Registered as a Newspaper in Ceylon

Rs. 3

VOL. CVI. NO. 3
JULY TO SEPTEMBER, 1950
(3rd QUARTER, 1950)

The Tropical Agriculturist

The Agricultural Journal of Ceylon

Founded in 1881
by the late MR JOHN FERGUSON C.M.G.

Published by
The Department of Agriculture
Peradeniya, Ceylon.

The

Tropical Agriculturist

Vol. CVI. PERADENIYA, JULY-SEPTEMPER, 1950 No. 3

Page

Editorial 101

ORIGINAL ARTICLES

The Propagation of Cacao from Cuttings by A. V. Richards 104

Ecological Conceptions and Vegetational Types—with special reference to Ceylon by R. A. de Rosayro 108

DEPARTMENTAL NOTES

Patana Fires in Estates and Water Catchments by R. M. Gorrie 122

Departmental Notes and News 124

SELECTED ARTICLES

The late Mr. F. P. Jepson 130

Soil Conservation 131

The Development of Under-Developed Lands by Prof. L. Dudley Stamp, University of London 133

The World's Food and Britain's Needs by A. N. Bassadone 135

MEETINGS, &c.

Proceedings of the sixth meeting of the Central Board of Agriculture held on May 27, 1950 138

Minutes of the meeting of the Board of the Tea Research Institute held on June 23, 1950 139

RETURNS

Meteorological Report, July, 1950 142

Animal Disease Return, June, 1950 143

The
Tropical Agriculturist
JULY TO SEPTEMBER, 1950

EDITORIAL

Paddy Milling and Marketing

THE conversion of the harvested paddy grain to an edible form is a far more complex problem than would appear from the primitive hand pounding process performed by villagers. The paddy grain consists of several parts all of which are of value and which can be put to good use. The general standard of the treatment of paddy in Ceylon mills leaves much to be desired and there are serious losses of bye-products which are of value. The Engleberg hullers in use are antiquated and inefficient, they consume an excessive amount of power in relation to the output and are wasteful of bye-products. There is no means of separating the smaller brokens and the highly nutritive meal from the broken-up husk and other rubbish. The so-called " bran " from these Engleberg machines is unfit for stock food and usually contains over seventy per cent. of broken husk. This unattractive blend of husk and meal can only be disposed of at low prices and the sale of it deprives the mill of the fuel value of the husk, compelling the miller to use another source of power, such as crude oil. The most economic method of disposal of the various parts of the paddy grain is to use an efficient train of machines which will separate each valuable product and leave the husk for use as boiler fuel. This is the system followed in all the larger rice-producing countries. The extraction rate for Ceylon paddy is 68 per cent. by weight but the Burma production of " rice and rice products " amounts to 74 per cent.

In modern milling the proportion of whole rice is 60 to 66 per cent. of the paddy and the husk is 20 to 21 per cent. The balance is made up of broken rice, bran and meal, which, when properly recovered and sold yield a substantial part of the income and may make all the difference between a profit or a loss on the milling.

What is required is a train of suitable machines which will efficiently separate the various parts of the grain and produce a good quality product. This train of operations should include cleaning, parboiling, drying, hulling (that is, removal of the husk alone), separation of small

brokens from the husk, utilization of husk for boiler fuel, separation of shelled from unshelled grain, pearling cones, and grading machines. It is a sound proposition to run the machinery on the waste husk, which otherwise costs money to dispose of. The furnace ash is a good source of potash suitable for paddy fields. For the efficient disposal of the rice and rice products large mills are necessary. These enable a large saving to be made on overhead charges but it is necessary, for efficiency, to run the machines a full 24 hours a day by shifts, especially when steam power is used.

An up-to-date mill should be large enough to handle such a volume of rice that overhead charges will amount to only a small proportion of the total running costs. It has been found in other countries that mills of a capacity of about 100 tons of rice per 24-hour day are efficient but smaller sizes lead to higher milling costs. The mill should run entirely on the husk and should have no fuel bill. By handling large quantities the miller can grade the paddy and so turn out a uniform product, obviating blending after the milling has been completed. The valuable bye-products are saved and add materially to the mill's income while providing good animal rations within the country. The mill should have large storage space to equalize milling through—put and avoid stoppages from shortage of supplies.

Large centralised mills of the type envisaged would turn out a better product than the wasteful " Englebergs " and reduce imports of fuel and animal rations. In some parts of Ceylon the concentration of paddy fields, particularly in the major colonisation schemes, is large enough to justify the erection of a number of large, modern mills.

A note in this number draws attention to the unsatisfactory method of marketing paddy, both from the point of view of the farmer and of the miller. The fixed standard is a bushel of 46 pounds weight but this weight can only be attained with very good winnowing or else damp paddy. To get the required weight the paddy will not be well dried with inevitable storage losses later. There are, in fact, some varieties which cannot attain the standard 46 pounds weight however well winnowed they may be and villagers cannot winnow efficiently with their primitive means. On the other hand the miller must be protected against purchasing empty husk and rubbish at the price of paddy and for this purpose some weight factor must be introduced into the transaction. The system followed in Siam and Burma, of a combined volume-cum-weight poundage allowance, has distinct advantages from both the seller's and buyer's view points and is not difficult to operate at mills.

A factor which has not hitherto been given much attention in Ceylon is the variability between varieties in the quantity of rice they can yield. Recent tests reported in the Department of Agriculture Report for 1949, show that amongst Ceylon paddies the gap between the highest and lowest rice outturns may exceed nine per cent., an amount of some significance in the food production of the country. It is unlikely that any premium for higher milling outturn of rice would ever be paid to the grower delivering small lots to a small miller, but the big miller could very well afford to pay a premium if he can obtain fairly large parcels of a variety having a proved high rice outturn. The advantage would escape notice when only a few bushels are handled but would be considerable in lots of 100 tons or more.

The quality of much of the locally-produced rice is very poor. The answer to the question " What is the best rice? " can only be " The rice you like best ", but the country rice samples now finding their way on to the markets are often deplorably unattractive. There is no system of grading and apart from a vague classification into " *samba* " and " others " there is little to distinguish one from another. The small miller treats each few bushels separately and generally pays the same price for all. That there is a demand for a better product is undoubted but the scarcity market enables the seller to dispose of almost anything which can be called rice. There is no need for this because, though some Ceylon varieties are not very palatable, they can be milled to give a reasonably clean and wholesome product. Inefficient drying, storage and milling must lead to a poor quality product and it is regrettable that a proportion of the Ceylon crop is injured by bad handling.

The Propagation of Cacao from Cuttings

BY

A. Y. RICHARDS
HORTICULTURAL OFFICER

SUMMARY

AN improved technique for the propagation of cacao from cuttings without the use of expensive cement concrete propagators is described. In preliminary trials over 93 per cent. success in rooting of stem and leaf cuttings was achieved in cloth-covered nursery beds containing rooting media of sand and coir dust. High atmospheric humidity was maintained over the nursery beds by allowing water to drip constantly on a row of porous bricks in the centre.

INTRODUCTION

Cacao does not generally breed true to type from seed, and the seedling trees exhibit considerable variability in habit of growth, yield and quality of bean. Vegetative propagation is therefore necessary for the production of uniform clonal planting material.

Budgrafting is a method of vegetative propagation which is comparatively easy to practice, but it does not eliminate possible differential stock-scion effect of the inherently variable seedling root stock. There is also the practical difficulty of having to remove sucker growth from the root stock of budgrated trees in the plantation. Stahel (1) reports that in the extensive trials with 36 clones at Trinidad budded trees were found to produce 30 per cent. less cocoa than trees grown from cuttings.

TECHNIQUE OF VEGETATIVE PROPAGATION FROM CUTTINGS

The technique of propagating cacao from cuttings was first developed in Trinidad by Pyke (2), and subsequently modified and improved by Cheesman and Spencer (3). It required the use of glass or calico covered cement concrete bins which had to be opened at least thrice a day for hand-watering the cuttings inside them. The propagators consisted of a battery of bins each 3 feet long, 2 feet 6 inches wide, and of height 3 feet at the back and 2 feet 10 inches in front, with a sloping glazed lid.

Similar propagators have been used with success for cacao propagation work in Surinam (4), West Africa (5) and Malaya (6). These I. C. T. A. propagators have also given over 80 per cent. strike at Peradeniya and Kundasale. Attempts at propagating cacao cuttings in glass covered pits under estate conditions in Trinidad by Pyke (7) were not successful, but by the use of a continuous spray of water as substitute for shade over the cuttings Bowman (8) working in Costa Rica was able to

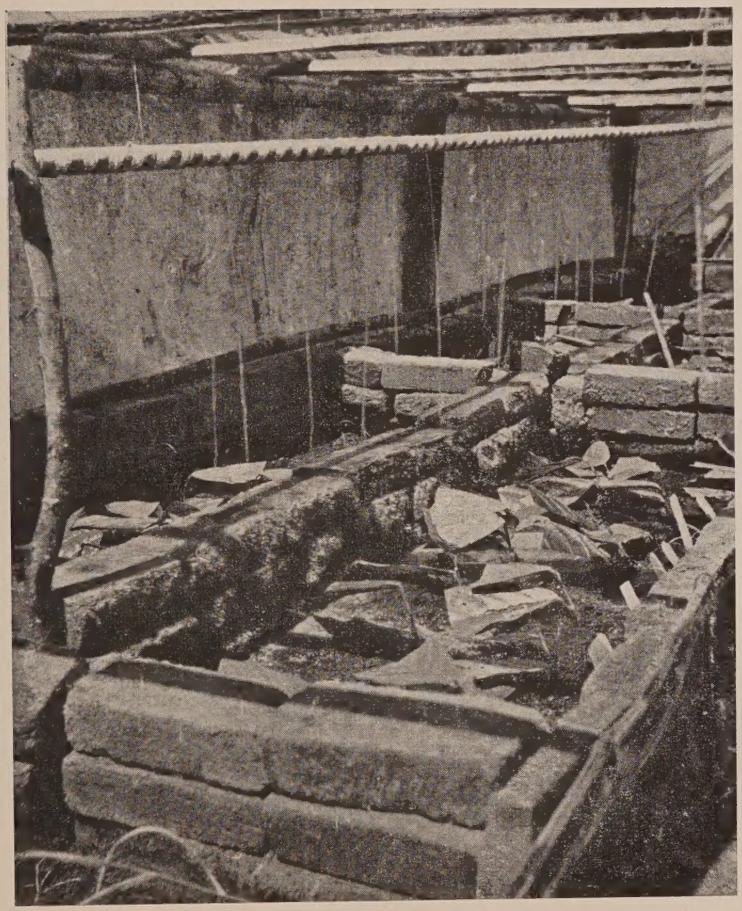


Fig. 1.—Inside view of Cacao rooting bed showing water dripping on centre row of bricks from overhead pipe line.

Fig. 2.—View of cloth-covered Cacao rooting beds.

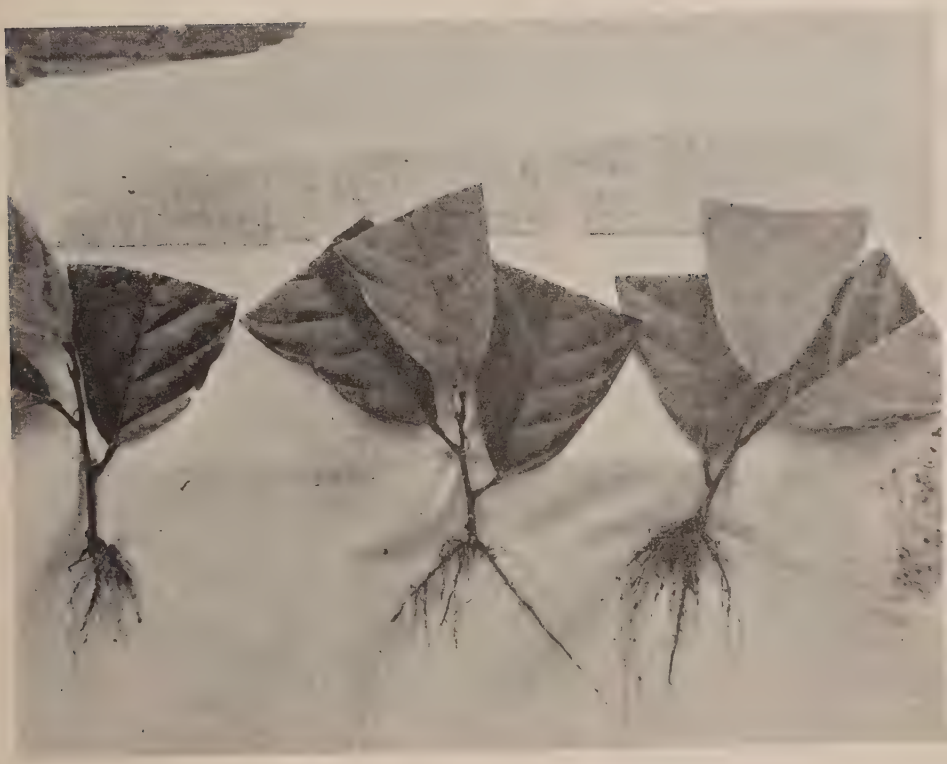


Fig. 3.—Rooted Cacao stem cuttings from rooting media of sand (left), soil (centre) and coir dust (right). Note development of root systems

Fig. 4.—Rooted Cacao stem cuttings from rooting medium of coir dust. Note fibrous roots holding lump of coir dust.

obtain a high percentage rooting of cacao cuttings treated with root growth promoting hormones in sand beds. This method requires a dependable pipe-borne supply of water and efficient power sprayers for production of fine misty spray.

In the preliminary trials at the Horticultural Nursery, Peradeniya, the nursery bed for striking cuttings was prepared by excavating the soil to a depth of about 15 inches and filling the pit partially with a layer of large stones and then with road metal to provide efficient drainage. The bed 4 ft. × 15 ft. was divided into three sections, each 4 ft. wide and 5 ft. long, for placing the three rooting media of washed coarse river sand, coir dust and soil under trial. The depth of each rooting medium was about 9 inches.

The entire nursery bed was lined on all sides by two layers of loose porous bricks, and in the centre with one row of bricks running the whole length of the bed. A length of galvanized iron piping with small holes drilled an inch apart in a line was placed horizontally over the centre row of bricks at a height of about 3 feet as shown in figure 1, and water was led into it from a rubber hose. The whole nursery bed was then covered with white longcloth draped over a framework of bamboo 3 feet 6 inches high (figure 2). Closely wooven coconut fronds (*cadjans*) could also be used for the sides, and only the top covered with long cloth.

TYPE OF CUTTINGS

Soft wood fan cuttings from the current season's flush which had just hardened were removed with the leaves from selected seedlings and bud-grafted cacao trees at the Experiment Station, Peradeniya, during showery weather and brought in bundles covered with wet jute hessian to the Horticultural nursery. The stems of the selected cuttings were quite firm though greenish in colour 3 to 4 inches from the tip. The cut ends were immersed in water and trimmed slant-wise with a sharp budding knife to produce cuttings 5 to 6 inches long with three leaves each. They were inserted to a depth of about 2½ inches with the leaves clipped in half from the apex to reduce transpiration.

Leaf cuttings with only one leaf and an internode were also used. About half the leaf was cut from the apex to reduce the transpiring surface.

An initial handwatering was given to all the cuttings immediately after insertion, and then water was allowed to drip on to the centre row of bricks from the galvanized iron piping and break up into fine droplets. A continuous drip was maintained day and night for about four weeks when roots began to appear. The flow of water was then stopped at night, and for two to three hours in the morning and evening, to prevent over saturation of the beds and consequent retardation of root growth.

RESULTS OF EXPERIMENT

The temperature of the rooting media fluctuated from 22.4°C, to 25.1°C, the soil being slightly colder than sand or coir dust, while that of the atmosphere inside the cloth cover varied from 22.8°C to 24.4°C. The

atmospheric humidity inside was always above 89 per cent. and on very rainy days 100 per cent. Table I gives the daily rainfall from June 1, 1950, when the cuttings were inserted, to July 7, 1950, when they were all examined for roots.

TABLE I

Date	*Rainfall in Inches*	
	June	*July*
1	0·01	0·47
2	0·21	0·21
4	0·16	—
5	0·02	—
6	0·28	0·10
7	0·15	—
8	1·59	—
9	0·37	—
10	0·45	—
13	0·38	—
14	0·03	—
16	0·07	—
17	0·34	—
21	0·14	—
22	0·77	—
23	0·50	—
24	0·84	—
25	0·07	—
27	0·08	—
28	0·24	—
29	0·10	—
30	0·38	—
Total	7·18	

It will be seen that there were in all 25 rainy days during this period.

The total number of stem cuttings inserted in each rooting medium and the total number rooted are indicated in table II.

TABLE II

Cacao stem cuttings in three rooting media

Source of Planting Materials	*Sand*		*Coir Dust*		*Soil*	
	Number inserted 1.6.50	*Number rooted* 7.7.50	*Number inserted* 1.6.50	*Number rooted* 7.7.50	*Number inserted* 1.6.50	*Number rooted* 7.7.50
Budgrafted trees	20	19	20	18	20	6
Seedling trees	8	7	8	8	8	2
Total	28	26	28	26	28	8
Percentage rooting	—	93%	—	93%	—	29%

Only 4 leaf cuttings were inserted as a preliminary trial in each rooting medium, and all the cuttings were found to have rooted in sand and coir dust, but none in the soil.

Stem cuttings treated with a proprietory root growth—promoting hormone in powder form showed no significant difference in rooting compared to untreated cuttings.

The root system of the cuttings from the three rooting media are shown in figure (3). Those from coir dust have well developed root systems with numerous thin fibrous roots which hold the coir dust firmly

Fig. 5.—Rooted leaf and stem cuttings of Cacao from rooting medium of coir dust.

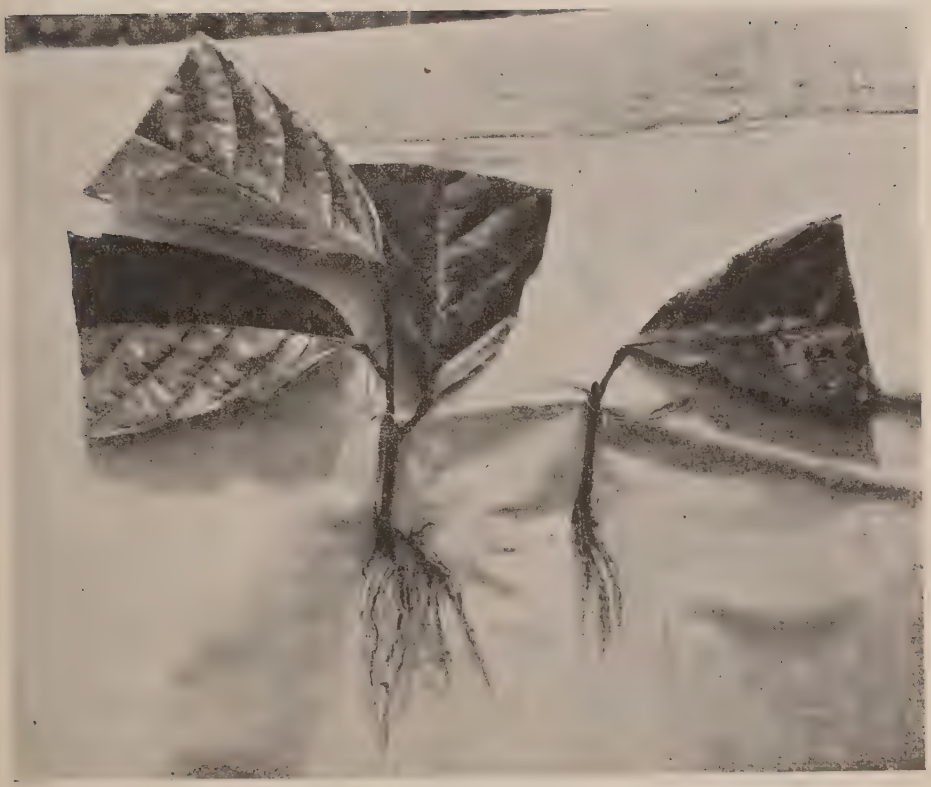


Fig. 6.—Rooted stem and leaf cuttings of Cacao from rooting medium of sand.

Fig. 7.—Rooted stem cutting of Cacao from I. C. T. A. propagator established in plant supply basket.

Fig. 8.—Cacao plant from rooted stem cutting transplanted into nursery for multiplication of planting material.

(figure 4), and transplant well. The cuttings from the soil have fairly long feeding roots, but those in the sand have smaller roots due perhaps to paucity of nutrients in the sand medium.

The root systems of the leaf cuttings are shown along with those of the stem cuttings in figure (5) and figure (6).

All the rooted cuttings were successfully transplanted on July 25, 1950, into plant supply baskets containing a potting mixture of leaf mould, good garden soil, and some sand to make it friable. The potted plants were allowed to remain under the cloth cover till they produced new shoots and became gradually hardened to stand exposure.

Preliminary trials with another set of cuttings also show great promise, and it is hoped to use this technique for large-scale production of rooted leaf cuttings under estate conditions during the monsoon which appears to be the best season for striking cacao cuttings. As indicated by Stahel (1) propagation is quicker and more economical from leaf cuttings than from stem cuttings since the gardens in which planting material is grown for multiplication could be smaller, and more cuttings could be accommodated in the nursery beds.

ACKNOWLEDGMENT

The writer's thanks are due to Mr. J. V. Pinto, Agricultural Instructor attached to the Horicultural Division, for invaluable assistance in the conduct of the preliminary trials.

REFERENCES

1. Stahel, G.—Gegevens over het cacaowerk in de cultuurtuin (Data on the work with cacao in Nursery Garden). *Cacaowerk*, Suriname 1949, pp. 4. *Hortic. Abstracts* June 1950, 1054.
2. Pyke, E. E.—The Vegetative Propagation of Cacao. First Annual Report on Cacao Research, Trinidad, 1931.
3. Cheesman, E. E., and Spencer, G. E. L.—The Vegetative Propagation of Cacao, Fifth Annual Report on Cacao Research, Trinidad, 1935.
4. Stahel, G.—The multiplication of Cacao by Leaf Cuttings. *Bull. Dip. Land Gproefstat*, Suriname 61, 1948, pp. 15, Bibl. 7 illus. *Hortic. Abstracts* December 1948, 2976.
5. Richards, D. A.—Notes on the Vegetative Propagation of Cacao. *Jour. Hort. Sci.* 1948, 24: 1929 Bibl. 13.
6. Keeping, G. S.—The Vegetative Propagation of Cocoa. *The Malayan Agric. Jour* XXXIII No. 1 Jan. 1950, pp. 27-31.
7. Pyke, E. E.—The Vegetative Propagation of Cacao IV. Propagation by softwood cuttings under Estate conditions. Third Annual Report on Cacao Research, Trinidad, 1933.
8. Bowman, G. F.—Rooting Cacao cuttings—An improved method. *Cacao Inf. Bull.* Turrialba, Costa Rica, 1948, 1: 5: 1 *Hort. Abstracts* September, 1948, 2218.

Ecological Conceptions and Vegetational Types with Special Reference to Ceylon

BY

R. A. DE ROSAYRO, B.Sc., B.A. (Oxon.), B.Sc. (Lond.)
ASSISTANT CONSERVATOR OF FORESTS

ABSTRACT

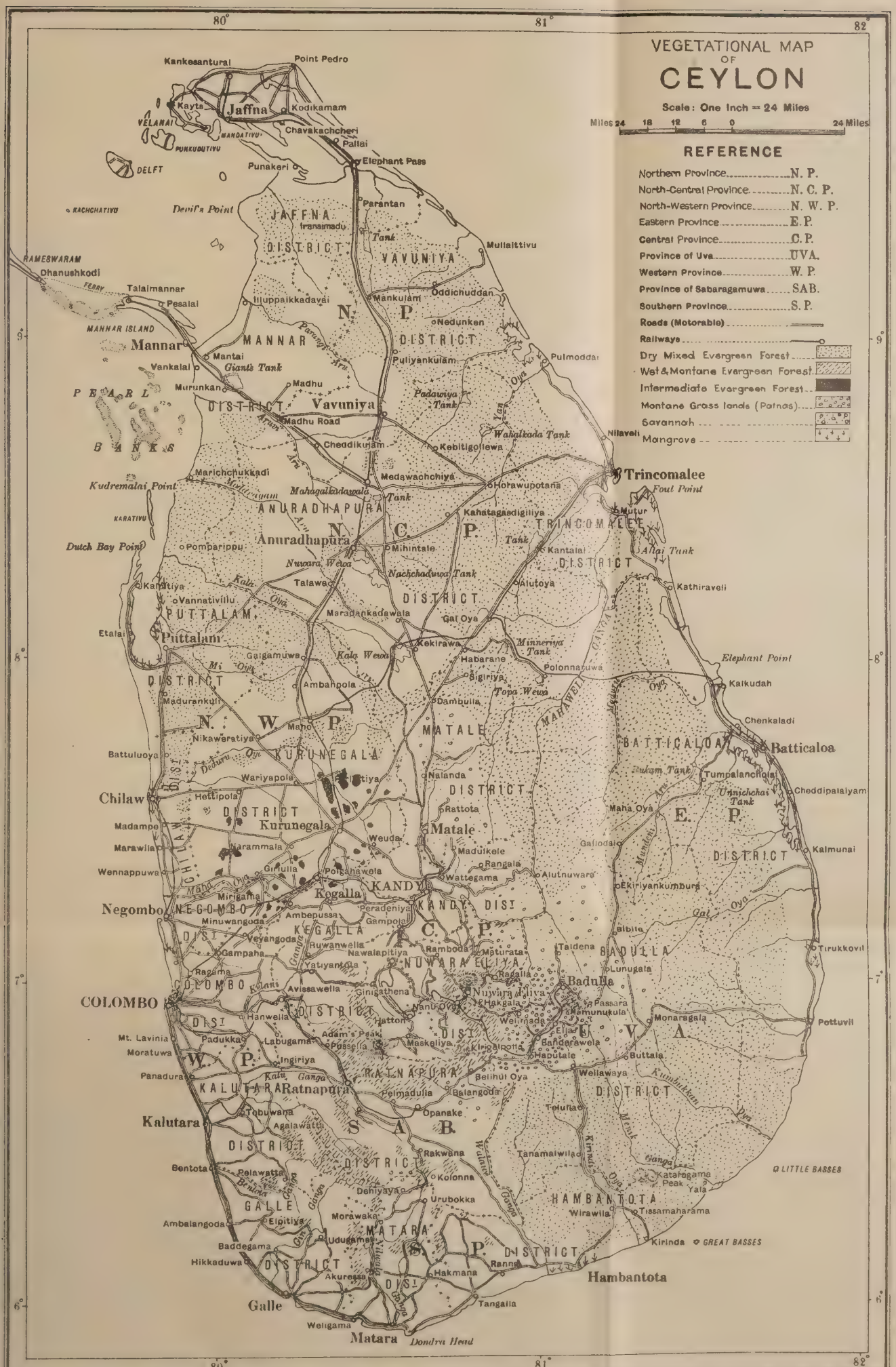
THE early plant-geographers at the end of the nineteenth century regarded vegetation as composed of geographic and relatively static units. With the recent advancement of ecological knowledge, this view has been replaced by a dynamic conception of the succession of vegetation. The distinction which exists between the two chief schools of thought in the interpretation of the theory of succession confuses and impairs the correct application and significance of ecological terms in common usage. The fundamental difference lies in the interpretation of the *Climax*, the *Monoclimax* concept admitting of only one type of climax, namely that controlled chiefly by the climate, while the *Polyclimax* concept distinguishes in addition to climatic climaxes, edaphic, physiographic and biotically controlled climaxes.

The fundamental ecological conceptions of succession, development and the climax, and the reasons for the divergence between the two schools of thought are examined. The *Monoclimax* concept as expounded by Clements although inclined to be too rigid and dogmatic is generally of greater value to the student on account of its clear and comprehensive treatment of the theory of succession. The terminology of Clements as applied to plant communities is briefly described and as far as possible related to that commonly used by the supporters of the Polyclimax concept.

An analysis of the natural vegetation of Ceylon shows that the Monoclimax concept is better applicable to the classification of our vegetational types and to the interpretation of their development. The classification of the major vegetational types of Ceylon which is briefly given supports this view. Two major climaxes, the Dry Mixed Evergreen Forest Formation and the Wet Evergreen Forest Formation and two minor climaxes the Montane Temperate Evergreen Forest and Montane Grasslands are recognized, and the communities occuring within them described and classified according to their successional relationship.

INTRODUCTION

The foundations of modern Plant Ecology may be said to have been laid towards the end of the nineteenth century with the classic works of the plant geographers Warming (1) and Schimper (2). With the advancement of ecological knowledge, the view of vegetation as composed of relatively



Crown Rights Reserved

Published under the orders of the Surveyor General, Ceylon, February, 1951. No 89

static geographic units under primarily climatic or to a lesser degree edaphic control has become replaced by a dynamic conception of the succession of vegetation. Modern ecology as an exact science has, to some extent, been vitiated by the inexactitude and divergence of opinion in the application of ecological concepts so as to create considerable confusion in the minds of students of ecology. The importance of a sound ecological foundation in the practice of agriculture and forestry has now been fully realized in all advanced countries, but the practical agriculturist or forester who has no time to specialize in this applied branch of biology looks for some simple and clear exposition of the problems involved in order to express himself lucidly and succintly. In fact, in the writer's opinion, many foresters are deterred for this reason from carrying out ecological research.

The interpretation of ecological concepts, chiefly the nature of the *climax* has given rise to two chief schools of thought. The first, the *Monoclimax* theory of succession of Clements and his chief supporters Phillips, Braun Blanquet, Pavillard, Cowles and Rübel has certainly received very clear exposition from Clements (3) and Phillips (4) in particular. Phillips' treatise is thorough and comprehensive but its philosophical approach and its very wide scope of treatment would make it beyond the pale of most practical ecologists.

The second school or *Polyclimax* theory of succession whose chief protagonists are Tansley, Nichols, Du Rietz, Nordhagen, Gams and Scharfetter, has more recently been ably expounded by a forester, Bourne (5), who strongly criticises the Monoclimax concept. Tansley's (6), exposition of the Polyclimax concept and its practical application is however of most value to the student.

The writer, who is a forester, admits that he has not acquired the wide ecological experience of the chief supporters of either school of thought, but feels that any effort in trying to relate these two apparently divergent views to each other would be more useful than to justify the need for separate conceptions! As such, he has attempted to explain in a logical manner the fundamental conceptions and relate them to each school. The recent Glossary of Ecological Terms compiled by Bor * (7), is a timely contribution to ecological literature, but without a clear understanding of these conceptions and the precise significance of the terminology in common usage, the scope of usefulness of such a glossary is very limited.

CLIMAX, SUCCESSION AND DEVELOPMENT

The conceptions of *Climax*, *Development* and *Succession* are the fundamental roots of dynamic ecology. It is proposed briefly to examine these concepts mainly in the light of the Monoclimax theory, as its treatment, especially by Clements, is more comprehensive, and as far as possible bring out the salient differences which exist between the two schools of thought.

Succession.—Succession is the process of change in vegetation involving the replacement of a plant community of one life form by another. The Monoclimax school (chiefly Clements and Phillips) holds that succession

* This is unfortunately incomplete, several important ecological terms in common usage being omitted.

is *progressive* only, i.e., proceeding from an organically inferior to a more advanced type, and brought about primarily by *biotic reactions*, i.e., the *internal* factors due to the activities of the plants themselves as distinct from *external initiating* causes. Tansley considers succession in its more general sense as simply the gradual change which occurs in vegetation. He distinguishes between *allogenic* succession, due to external causes (climatic and physiographic) and *autogenic* succession due to internal causes, i.e., biotic reactions. His view is that while development or autogenic succession is progressive, allogenic succession may be retrogressive. Phillips has shown that Clements' and Tansley's views can be closely related if one considers that succession can be accelerated, retarted, deflected, interrupted, postponed or even terminated by external acting factors either climatic, physiographic or biotic (i.e., the influence of man and animals). He has accordingly suggested the expressions "succession-acceleration", "succession-retardation" &c., to cover these possibilities. *Convergence* towards a climax is a general trend of all succession. Primary succession or the *prisere* may be distinguished from secondary succession or the *subsere;* the latter follows the removal of the original vegetation by artificially induced factors such as felling, burning, &c.

Development.—The conception of development is intimately connected with succession. Development is a process involving the establishment, growth and reproduction of plant communities. The factors of completion, co-action and re-action are inherent in plant communities. The development of a community proceeds until it reaches maturity when it is replaced in *succession* by a community of a higher life-form until a climax stage is reached. Clements and his followers hold that development being closely allied with succession is progressive only and due entirely to biotic reactions, i.e., *the* activities of the plants themselves (and animals in a common role). The plant community is conceived as a *complex-organism* (Clements) or *quasi-organism* (Tansley). Tansley's view is that while development is only progressive, succession may be progressive or retrogressive.

Climax.—The climax is the fundamental concept of modern ecological thought. It is regarded as the *final* stage in the succession and development of vegetation. Clements and his supporters have given to the climax a clear and unequivocal conception. The climax is the result of successional development which is always progressive; it is brought about by *biotic* reactions of the plants themselves within the limits of the climate (i.e., all the various complex factors that together comprise the climate). A climax is in equilibrium with the prevailing climate. The tendency in the past, and perhaps may also be read into Clements' treatment, is to regard the climax as completely *stable* and *permanent*. This view is not strictly correct. For the purpose of recognition of climaxes some degree of comparative stability must be admitted. No single factor which contributes to the succession and development of vegetation can be regarded as entirely stable. Judged from human standards, stability over a long period of time is a sufficient criterion of a climax.

The intrinsic difference between the Monoclimax and Polyclimax views lies in the concept of the climax. Whereas the Monoclimax concept

admits of only one type of climax, namely that controlled by the climate, the Polyclimax concept postulates more than one type of climax, viz., *clomatic*, *edaphic*, *physiographic* or *biotic* according to the factors which exert the dominating influence on the vegetation. In other words, while recognising climatic climaxes in which the climate is the chief controlling factor, they recognize climaxes controlled by edaphic (i.e., soil) factors, physiographic (i.e., topographic) factors and finally biotic* factors, i.e., by the externally acting biotic agencies of man or animals (including fire brought about by man).

Clements and his supporters regard climate not in its narrow sense as a series of measurable factors but as an expression of the vegetation itself. Within the limits of a climatic region, local variations in climate are to be expected with corresponding variations in the general vegetational type. The term *formation* as used by Clements is synonymous with the climax.

A close analysis of the Monoclimax and Polyclimax concepts reveals that the important points of deviation are firstly, the relative values attached to the factors governing the establishment of the climax and secondly, the difference in conception of the climax itself corresponding to the importance attached to variations in the general vegetational type. These two points of deviation are intimately related. The supporters of the Polyclimax concept attach great importance to the control exerted by the soil factor complex on the vegetational type, in particular the availability of soil moisture, which according to this concept may play a *dominant* role in the control of vegetation. Such climaxes are termed *Edaphic* as distinct from *Climatic* Climaxes in which the climate factor-complex is regarded as being dominant. Variations within the climax, consequent on altered soil conditions are admitted and accounted for by the Monoclimax concept which, however, regards the edaphic conditions to be secondary and actually under the control of the master factor-complex of the climate. A similar distinction has resulted in the recognition of *Biotic Climaxes* where interference or disturbance brought about by man or animals are held by the Polyclimax School to produce the dominant factor-complex.

Certain aspects of Clements' treatment of the climax are inclined to be somewhat far-fetched, obscure and perhaps too dogmatic. The climax is conceived as an *organic entity*; both Clements and Phillips place too much emphasis on this view thus obscuring the essential dynamic nature of the climax and its diversified form in development. The development of the climax by successive progressive stages of communities which replace each other is also too rigid a conception. More recently Watt (8), has shown from observations made in communities of different life forms including grassland, fernland and beechwood communities in England, that plant communities are composed of characteristic patches or mosaics which exhibit a *cylic* succession rather than a straightforward progressive development from communities of lower to a higher life form. The same point of mosaic structure in vegetation has been brought out by Morison and his co-workers

* *Note.*—Biotic reactions as considered by Clements should not be confused with the reactions produced by *external* biotic factors. Clements adopts the term *Biome* to denote a climax in which vegetation and animals are considered in a mutual role.

(9) in recent studies in the Anglo-Egyptian Sudan associated with changing soils and *catenas*. These findings do not vitiate the essential fundamental hypotheses of succession and development but indicate that certain modifications in normal development and succession should be recognized.

UNITS OF VEGETATION

The tests of a climax lie in a proper study of its ontogeny (recent history) and phylogeny (prehistory). The presence of climax dominants or controlling species is an ontogenic test of a climax which should be considered in relation to its prehistory as far as evidence is available. For instance the prairie and deciduous forest climaxes of North America not only show characteristic climax dominants but from a study of their fossil and geological prehistory clearly indicate that they exhibit a high degree of stability and were evolved 20 to 30 million years ago. The climax in Clements' view is of wide conception often continental in extent. The dry mixed evergreen forest and wet evergreen forest formation in Ceylon are examples of true climaxes. This wide conception of a climax is expressed in terms other than climaxes in the Polyclimax view giving it a different status. Such climaxes are designated climatic vegetational types of the world or climatic plant formations (Tansley), the term climax being restricted to smaller units of more uniform structure and composition, *e.g.*, Beech-Birch-Oak-*Leucobryum* climax of Bourne (5) in British Woodlands.

Proclimax.—Clements distinguishes between climaxes of the fundamental climatically controlled type and *Proclimaxes* (a term of recent introduction) embracing more or less permanent (i.e., relatively stable) communities simulating the climax but lacking the sanction of the existing climate. Such communities would be normally replaceable or succeeded by the true climax when the inhibiting factor or factors are removed. The Proclimax is a general term including sub-climaxes, pre- and post-climax and disturbance or dis-climaxes, all of which are given a specific character and meaning. The term sub-climax in the past did dual duty for sub-, pre- and post-climaxes.

Sub-climax and Dis-climax.—The sub-climax is the sub-final stage in either primary or secondary succession preserved as a relatively stable phase by continuous or repeated disturbance due to natural, other than climatic factors or artificially introduced factors such as logging, grazing, burning, &c. The sub-climax differs in one important respect from a *disturbance climax* (or *Dis-climax*) produced by the same factors or combination of these factors in that in the latter, the true climax or succession has been *permanently deflected* into a climax of inferior life forms which is not likely to succeed to the true climax. The distinction between these two types of climaxes may be some times a matter of judgment, so that, in some instances either sub- or dis-climax may be correctly applied. Examples of sub-climaxes in Ceylon are seen in the *Manilkara-Hemicyclia-Pterospermum-Randia* (palu-wira,welang-kukurumam) community which is widespread within the dry mixed evergreen forest formation and the *Vitex-Wormia-Chaetocarpus-Anisophyllea* (milla-diyapara-hedawaka-pepaliya) community which is of frequent occurrence in the wet evergreen forest formation. Examples of dis-climaxes are grasslands and fernlands in the wet evergreen

forest climax and grasslands within the dry mixed evergreen forest climax brought about by shifting cultivation and subsequent burning. The disturbance climaxes are maintained in their present condition by continuous burning. Where there is arrested development in an earlier sub-seral state for a relatively long period, Clements has suggested the term *Serclimax*. For the most part, such climaxes are found where conditions of impeded drainage are encountered. The mangrove communities occurring in estuaries and lagoons may be considered an example of this.

Pre- and Post-climaxes.—Two other important types of climaxes are also distinguished by Clements which are not given exact or sufficient recognition in the Polyclimax concept. These climaxes are based on the recognition of relics existing as relatively permanent and extensive communities with the climax. For this the terms *pre- and Post-climaxes* have been applied. These climaxes are associated with the conception of the *Clisere* which may be expressed as a sequence in space and time of climaxes consequent on major climatic variations such as the Ice Age, or in this country, by the corresponding Wet and Arid periods in the Island's prehistory. In the general application of the Clisere, every climax except extreme types is either post-climax to inferior life forms or pre-climax to more advances life forms, e.g., savannah is post-climax to grassland but pre-climax to forest. The more precise application of these climaxes is however to well-recognisable and widespread *relict* communities which occur within the climax due to the compensation afforded by edaphic factors consequent on topographical variations or geological causes, e.g., in valleys, gorges or steep slope exposures. The term *seration* distinguishes an edaphic sequence similar to a clisere brought about by graduated edaphic change, e.g., across a valley. This concept fits in very well with the *catena* in recent soil-terminology, i.e., a series of soil types associated with similar topographical variations. The catena is particularly well exemplified in Africa (10).

Pre-climaxes and Post-climaxes should be carefully distinguished from priseral phases. Wherever they are recognized, they are important relics which indicate the earlier conditions prevalent in the area, having survived important or major climatic changes. Examples of post-climaxes in Ceylon are the riparian forest belts in the dry patana climax; of pre-climaxes, the wet *patanas* in the montane evergreen forest climax.

The Polyclimax Concept (*Edaphic and Biotic climaxes*).—The acceptance by the Polyclimax School of *Edaphic* and *Biotic* climaxes of the same status as the climatic climax appears to be justified under some conditions, particularly to regions where fairly uniform climatic conditions are found, such as in England. Here edaphic variations and human influences have created distinct communities which are given the status of climaxes. Bourne, a forester, in an able exposition of the Mono- and Poly-climax concept (5) relates the climax to maturity of site. "Every topographic site or soil is potentially a climax habitat" for which a distinct vegetation climax is expected. On this premise, he concludes that the majority of climaxes are *edaphic* climaxes. There is doubtless justification for this view especially from Bourne's wide experience of forest typs in England and the Continent, particularly France and Germany. Such a

differentiation into small edaphically controlled units of vegetation, however, detracts from the fundamental concept of the *climax*. Phillips (4) has suggested that Bourne's edaphic climaxes could be expressed by the terms *seration*, *faciation* or *lociation* whichever is correctly applicable to the particular edaphic climax. In the writer's opinion the concepts of pre- and post-climaxes as relict communities are also frequently applicable to edaphic climaxes. *Biotic climaxes* can be better designated as *Disclimaxes* where the deflection is relatively permanent and *sub-climaxes* where the change cannot be regarded as completely persistent.

UNITS OF THE CLIMAX

Every climax is characterized by the presence of climax *dominants* or controlling species which are typical of the highest life form of the community. Clements has also suggested the term *perdominant* for controlling species which bind the various associations of the community and *eudominants* for dominants peculiar to a particular association. These terms are however not in common usage. *Sub-dominants* are however universally accepted as being species belonging to a lower life form than the dominants and are subject to the control of the former. This is well exemplified in the forest climaxes where the dominants are in the overwood or topmost layer and the sub-dominants in the understorey.

Association.—Every climax is characterized by the presence of two or more *associations* which are communities associated regionally to constitute the climax. Associations are differentiated mainly by sub-climates occurring within the range of the climax. The term *consociation* is used where a single species can be distinguished as the dominant in the community. An association is characterized often by several dominants, two or three of the most important usually giving the association its distinguishing name, e.g., the *Mesua-Doona* (na-dun) association of the wet evergreen forest climax. An example of consociations is the *Dipterocarpus* consociation of the same formation.

Faciation and Lociation.—Two other important sub-divisions of the association are recognized by Clements, viz., the *faciation* and the *lociation*, terms which have not yet found universal acceptance. The faciation is a concrete sub-division of an association produced by important climatic variations within it. In fact, an association is composed entirely of faciations. Faciations are recognized by the different grouping together of the dominants which constitute the association. An example of a faciation is the *Durio-Doona-Palaquium-Myristica* (kataboda-tiniya-dun-kirihembiliya-malaboda) community of the *Mesua-Doona* association mentioned earlier. The lociation is a further sub-division of an association associated chiefly with smaller variations in the site conditions, i.e., generally topographic changes, e.g., the *Camnosperma* (aridda) lociation in the wet evergreen forests. Careful study of communities is necessary to distinguish faciations and lociations within climax associations.

Society.—The term *Society* is applied to groups of sub-dominants within the association or faciation, locally exerting a controlling influence. In forests, societies are relegated to the understorey layers and are

accordingly termed *layer societies*, e.g., the *Strobilanthes* (nellu) layer in the montane temperate wet evergreen forests. Seasonal variations produce *aspect societies*. These societies are designated by Clements as *sociations*, i.e., aspect societies, *lamiations*, i.e., layer societies and *sations* for layer societies which show seasonal rhythm. The term *Clan* is used for smaller communities of subordinate interest which are of distinctive recognisable character.

Societies and Forest Types.—Plant communities in the undergrowth have also been assigned a role of importance in associationship with the climax dominants. Cajander (11), in Sweden has found that a close relationship exists between forest and undergrowth communities, so much so, that a combination of the principal dominants of the tree and ground flora layers are used in the classification of forest types. Bourne (5) also gives considerable importance to ground flora communities in distinguishing forest climax communities, e.g., the Spruce-Fir-*Mulgedium* type in the forests of the French Jura. In our forests, the distribution of shrub and ground flora layer societies appears to be more ubiquitous except for sub-climax and seral forest types whose undergrowth communities are often characteristic and of specific indicator value of the sub-climax or seral development phase.

Seral Units.—*Seral* units are given the same equivalent terms as for climax units, the same principles of classification applying to the developmental sequence, viz., the concepts of dominance and sub-dominance in the grouping together of species. Both priseral and sub-seral units are treated alike. The terms *associes*, *consocies*, *facies* and *locies* are thus applied to seral communities and have precisely the same significance and application within the smaller ambit of the sere or the subsere as the association, consociation, faciation and lociation to climax communities. Similarly the terms *socies* and *family* correspond in application to the sociation and clan. The *colony* is an aggregation of families.

Ecotone and Mictium.—Two other important vegetation units, the *Ecotone* and *Mictium* may also be recognized. The ecotone is a mixed vegetational type occurring where there is a merging of two climaxes and a mictium a mixed type which intervenes between two seral or sub-seral stages. The " intermediate " wet evergreen forests is an example of an ecotone between the wet-and dry mixed-evergreen types. It contains dominants of both climaxes as well as locally dominant species which are characteristic of the ecotonal climatic zone, e.g., *Artocarpus nobilis* (del) and *Filicium decipiens* (pihimbiya).

COMPARISON OF POLYCLIMAX AND MONOCLIMAX TERMINOLOGY

The Polyclimax School recognizes the same general terminology for climax and seral units although some terms proposed by Clements are not generally accepted. The summary below gives as far as possible the relationship between the terms of common usage of both Schools.

	Polyclimax Concept (mainly after Tansley)		*Monoclimax Concept (mainly after Clements)*
I.—Climaxes ..	Plant formation ..	=	Formation or Climax
	Formation types (i.e., vegetational types belonging to the same life form, e.g., deciduous forest, wet evergreen forest, &c.)	=	Panclimaxes (e.g., artic, boreal, deciduous forest panclimaxes)
	Climatic vegetation types of the world Climatic plant formations .. Climatic climaxes ..	=	Climaxes or Formations
	No equivalent term ..	=	Eoclimax (an ancestral climax)
	Edaphic formation or Edaphic climax	=	Serclimax or Post —or Preclimax or Subclimax { as distinguished by an analysis of the community and its history
	Plagioclimax ..	=	Disturbance climax or Disclimax
	Biotic (usually anthropogenic climax) (some of these may be distinguished as plagioclimaxes)	=	Disclimax or subclimax (as distinguishable from an analysis of the community and its history)
II.—Climax Units	Association ..	=	Association
	Consociation ..	=	Consociation
	No proper corresponding terms. Edaphic climaxes may sometimes apply to these	=	Faciation Lociation
	Dominant species ..	=	Dominants
	Co-dominant species ..	=	Dominants of equal status (the term co-dominant is considered redundant)
	Exclusive species ..	=	Eudominants
	Subordinate species ..	=	Subdominants
	Indifferent or casual species	=	Edominants
	Strata or layers (includes both climax as well as seral units)	=	Lamiations (climax units) or Lamies (seral units)
	Includes both climax as well as seral units { Habitat society	=	No equivalent term "Clan" may sometimes apply
	Stratum society	=	Layer society (lamiation or lamies)
	Aspect society	=	Aspect society (sociation or socies)
	Synusia (a unit of plants of similar life-form associated with *seasonal* changes in climatic or edaphic conditions)	=	No equivalent term
	Ecotone	=	Ecotone
III.—Seral Units	Prisere	=	Prisere
	Subsere	=	Subsere
	Plagiosere	=	Deflected succession (subsere)
	Associes	=	Associes
	Consocies	=	Consocies
	Strata or layers ..	=	Lamies (vide above)
	Societies	=	Lamies or Socies (vide above)
	No equivalent term ..	=	Mictium
IV.—General Terms	Autogenic succession ..	=	Succession due to internal biotic factors, i.e., of the plants themselves.
	Allogenic succession ..	=	Succession due to continuously acting external factors
	Autecology (ecology of the individual plant)	=	Autecology
	Synecology (ecology of plant communities)	=	Synecology

CLASSIFICATION OF THE VEGETATIONAL TYPES OF CEYLON

The natural vegetational types of Ceylon conform in analysis very closely to the Monoclimax concept in that climate is clearly the controlling or master factor in the expression of the vegetation and edaphic factors are clearly secondary and subordinate to the climatic factor. In fact climate

Photo. 1—Puwarasankulam in Vavuniya District. An example of the Manilkara–Hemicyclia–Chloroxylon–(Vitex) association with Holoptelea integrifolia Planch.

Photo. 2.—Hurulu Reserve in Anuradhapura District. Also Manilkara–Hemicyclia–Chloroxylon association with Chloroxylon swietenia DC. (satin) predominating.

Photo. 3—Hurulu Reserve in Anuradhapura District. An example of the Alseodaphne–Berrya–Diospyros association. The straight tree in the centre is Alseodaphne semecarpifolia Nees (*ranai*). Hemicyclia sepiaria W. & A. (*wira*) is seen on the extreme right with characteristically fluted bole.

Photo. 4.—Kantalai Reserve in Trincomalie District. An example of the Hemicyclia–Pterospermum–Manilkara–Bauhinia &c., scrub subsere with Dimorphocalyx glabellus also very frequent.

Photo. 5.—Kumbu upiddy Other Crown Forest in Eastern Province. An example of grassland (Imperata arundinacea consocies) in the foreground. Scrub subere with Randia and Memecylon species predominating in the background.

(Photos 1–5 by V. Ramalingam.)

is also the chief determining factor in the composition of the soils of Ceylon. Except for local outcrops of soils of Miocene, Jurassic and Pleistocene derivation in which the rock formation is the chief soil-characterizing agent, the soils of Ceylon which are mainly Archaean in origin show a great uniformity in structure and composition (12).

Major Climaxes.—Two major climaxes of Ceylon may be distinguished :—

I.. The Dry Mixed Evergreen Forest Climax.

II. The Wet Evergreen Forest Climax.

These two climaxes of conspicuously different vegetational types are well defined and clearly distinguished as reflexes of two distinct climates, the former, of a comparatively dry climate with an annual average rainfall of 40 to 75 inches mainly during the north-east monsoon, the intervening period being one of drought, with drying winds during the south-west monsoonal season. The wet evergreen forest climax is associated with a wet climate of continuous and heavy rainfall (above 75 and up to 200 inches or more, annually), the bulk of which falls during the south-west monsoon.

I. *The Dry Mixed Evergreen Forest Climax.*—This climax would originally have occupied about two-thirds of the land area of Ceylon in the " dry " and " arid " lowlands. It consists typically of mixed evergreen and deciduous trees whose dominant height growth seldom exceeds 75 feet with poor bole formation, heavy branching and sclerophyllous leaves. The overwood canopy is typically open with generally thorny shrub undergrowth. The dry mixed evergreen forest communities have not been fully investigated ecologically; tentatively, two major climax *associations* are suggested by the writer. The first, the *Manilkara-Hemicyclia-Chloroxylon-(Vitex)* (paluwira-satin-(milla)) association is of more general occurrence and includes a number of faciations, as described by Chapman (13), in which one or more of these dominants show greater gregariousness; these faciations are clearly related to climatic variations within the climax. This association is often degraded by shifting cultivation or excessive fellings into a " low jungle " *sub-climax* characterized by the same species with other notable dominants such as *Pterospermum canescens* (welang), a poorer distribution of trees in the overwood and a corresponding diminution in the tree height growth. Several subseres characterized by low tree-shrub associes or thorn-scrub associes are also recognized.

The second climax *association* is ecologically a more advanced community associated with a sub-climax of more humid conditions. The *Alseodaphne-Berrya-Diospyros* (rana-halmilla-ebony) association finds its best development in the vicinity of streams, i.e., with moister soil conditions and thus may possibly be a relict climax, i.e., a *post-climax* association. This community shows the best growth and form in the dry mixed evergreen type. Other more localized and typically edaphically controlled communities associated with fresh or salt-water swamps and sand-dunes are considered *serclimaxes;* these are clearly, purely local units of distinct vegetational type *within* the major climax. Finally, *disclimaxes* or grassland produced by continuous burning are also recognized.

II. *The Wet Evergreen Forest Climax.*—This climax is associated with the wet zone of Ceylon in the west and south-west lowlands and semi-montane regions. It would originally have occupied about a quarter of the entire land area of the Island. The typical vegetational type is high forest with dominant tree height growth up to 150 feet, a typically closed canopy, a dense understorey and a heavy undergrowth of shrubs and perennial herbs, with climbers and epiphytes on the trees. The crowns of the overwood trees are rounded and compact with large, thick and succulent leaves, often with drip-tips. The wet evergreen forest communities have been studied by the writer and described in detail (14). Two specific associations have been recognized, viz., the *Dipterocarpus* (hora and bu-hora) consociation and the *Mesua-Doona* (na-dun) association. The former shows its best development in alluvial, riverain sites and along valleys and depressions. It is also closely related phylogenetically with the *Dipterocarpus* communities of the Indo-Malayan region. The *hora* consociation exhibits the best form and growth of all wet evergreen forest communities. The *Mesua-Doona* association along with its *faciation* the *Durio-Palaquium-Myristica, &c.* (kataboda-kirihembiliya-malaboda, &c.) community is found on the lower montane regions of the wet evergreen forest type. It is only slightly less inferior in height, growth and tree-form to the *hora* conso ciation. Both associations have been arrested in their spread and development by shifting cultivation or excessive feelings.

A sub-climax of widespread distribution has also been distinguished. The *Vitex-Wormia-Chaetocarpus-Anisophyllea* (milla-diyapara-hedawaka-welipenna) associes is generally inferior in height-growth, &c., to the climax association. "Low-jungle" and scrub *subseral* stages have also been recognized; it was formally thought that the communities of the lower life-forms, viz., fernland (*Gleichenia linearis*) and grassland were dis-climaxes brought about entirely by fire. Further observations since made by the writer indicate that they may also be the earliest *subseral* stages, in the absence of disturbance progressing to the *Hedyotis-Osbeckia, &c.*, scrub subsere.

THE "INTERMEDIATE" WET EVERGREEN FORESTS

Between the two major climatic wet and dry zones a climatic zone of intermediate character may be recognized, corresponding roughly to a zone of about 70 inches to 100 inches rainfall, in which the vegetational type is correspondingly very mixed. This type is clearly an *Ecotone* confined to this zonal belt which obtains its best development in the North-Western Province, chiefly the Kurunegala District. The vegetational type shows affinity to both wet and dry mixed evergreen forest types. Certain specific dominants not normally dominant in these two climaxes are, however, observed. The *Artocarpus-Vitex-Filicium-Pterospermum-Nephelium* (del-milla-pihimbiya-welang-mora) community is characteristic of this region, but as these forests have been heavily exploited, it is probable that it corresponds to a *sub-climax* condition.

Minor Climaxes.—Two minor climaxes, the *Montane Temperate* or *Sub-Tropical Evergreen Forest* and the *Montane Grasslands* (or *Patanas*) are recognized, although the latter is not considered a true climax by some

Photo. 6.—Kottawa-Kombala Proposed Reserve in Galle District. An example of the Dipterocarpus zeylanicus Thw. (*hora*) consociation, the best developed community of the wet evergreen forest climax.

Photo. 7.—The same area as in photo. 6 showing fine bole and crown development of *hora*. Understorey of Agrostistachys and Schumacheria.

Photo. 8.—Diyadawa Reserve in Matara District. A general view of wet evergreen forest. In the foreground may be observed a scrub associes, viz., Hedyotis–Melastoma–Osbeckia coming up in old chena. On the lower slopes, the Vitex–Wormia–Chaetocarpus–Anisophyllea sub-climax predominates, and on the upper slopes the Mesua–Doona climax association.

Photos. 9 & 10.—Kanneliya Reserve in Galle District. A good example of the Mesua–Doona climax association with Doona trapezifolia Thw. (*yakahalu-dun*) in the foreground (the large trees) and Mesua ferrea L. (*na*) in the background. There is also a good understorey of these species. The large leaved tall shrub is Agrostistachys longifolia Benth.

Photo. 11.—Kanneliya Reserve in Galle District. An example of the Durio–Doona–Palaquium–Myristica faciation of the Mesua–Doona climax association. Doona trapezifolia Thw. (*yakahalu-dun*) and Mesua ferrea L. (*na*) in the foreground ; Durio zeylanicus Gardn. (*kataboda*) in the background, specially in the understorey.

Photo. 12.—Kirinda-mahayaya Reserve in Matara District. A general view of the Vitex–Wormia–Chaetocarpus–Anisophyllea–(Dillenia) sub-climax. The inferior growth and form of the trees in comparison with the climax types (photos. 6–11) is evident.

Photo. 13.—Kottowa–Kombala Proposed Reserve in Galle District. Scrub jungle subsere of Macaranga–Trema–Wendlandia–Ochlandra associes. Macaranga peltata Muell. Arg. (*kenda*) to be observed on the right foreground coming through a thicket of Ochlandra stridula Thw. (*bata*). The forest in the background is a sub-climax type (Vitex–Wormia, &c.)

Photo. 14.—Kottowa–Kombala Proposed Reserve in Galle District. Fernland (Gleichenia linearis) subsere (disclimax ?) in the foreground with regeneration of Ochna spp., Hedyotis fructicosa L., &c., coming through. In the background is a typical low jungle subsere of the Aporosa–Chaetocarpus–Vitex–Anisophyllea associes. The heavily branched tree on the extreme right is Aporosa latifolia Thw. (*pepaliya*).

workers. Both these climaxes are closely associated with climatic variation induced by altitude and physiography. They also appear to be intimately related to their geological prehistory of tectonic movements and peneplanation of the Archaean rock mass, and swamp and arid phases in the pleistocene times.

(i) *Montane Evergreen Forest.*—The montane forest type occurs between an altitudinal range of about 3,000 to 8,000 feet. At the lower elevations the type alters imperceptibly into the wet evergreen climax. The typical montane forest is a stunted inferior type; with increasing altitude, tree growth decreases till finally an elfin woodland-type is reached where dead and drying trees are frequent. A mixed community, which may be termed the *Syzygium-Calophyllum-Gordonia-Michelia* (damba-kina-mihiriya-sapu) association characterizes the type. On account of the difficulty of obtaining natural regeneration of the indigenous tree species, Holmes (15) has suggested that the montane type is a prehistorical relict type, i.e., a *post-climax* of the wet evergreen forest which has been lifted up by tectonic upheaval outside its environment. This view is interesting and agrees with the writer's earlier view that the *patanas* are similarly a relic type (16).

Within the montane zone, the "wet" montane grassland or *wet patanas* occurring at high altitudes are characterized by the *Chrysopogon-Pollinia-Arundinella-(Rhododendron)* associes; the wet *patanas* occur as a local swamp or edaphically conditioned type which is profoundly altered by fire. This type of grassland may be considered either a *pre-climax* (or *ser-climax*) or *dis-climax,* depending on the importance attached to either the edaphic or external biotic factors.

(ii). *Montane Dry Patanas or Grasslands.*—The *dry patanas* which occur specifically in the Uva Basin at lower altitudes roughly between 3,000 to 5,000 feet are characterized by the *Themeda-Arundinella-Pollinia-Cymbopogon* association and a shrub-*Cymbopogon-Pteridium* faciation. The latter is conditioned by a moister micro-climate induced by valleys or depressions. This type is held by the writer to be a true *climax* of great antiquity much modified by the external biotic factors of fire and grazing (16). Drought and strong drying winds are important climatic factors inhibiting the growth of indigenous tree species. The purely riparian forest belts may be considered an edaphically conditioned *post-climax* (16).

The Savannah Ecotone.—Between the dry mixed evergreen forest and montane grassland, a wide *savannah* belt occurs characterized by the *Anogeissus-Careya, &c.—Cymbopogon-Imperata* (dawu-kahata-mana-illuk) community (13) of scattered, stunted trees in grassland. This savannah type is considered by the writer as an *ecotone* modified by fire. Grasslands of *mana* or *illuk* occurring within this zone may be viewed as *dis-climaxes* in which fire plays the dominant role.

SUMMARY OF CLASSIFICATION OF THE VEGETATIONAL TYPES OF CEYLON

The following summary which is not intended to be exhaustive covers the main vegetational types of Ceylon considered according to their successional relationships. Except for the wet evergreen forests and

montane grasslands, this classification is tentative and based in the main on the writer's observations confirmed by Chapman (13). A full ecological investigation is however necessary for the other communities chiefly of the important dry mixed evergreen forest climax and montane temperate evergreen forest.

I.—DRY MIXED EVERGREEN FOREST CLIMAX

High forest type	*Climax Associations* ..	1. *Manilkara-Hemicyclia-Chloroxylon* (*Vitex*) association 2. *Alseodaphne-Berrya-Diospyros* association
	Faciations of 1 (vide Chapman (13))	(i) *Manilkara* faciation (ii) *Manilkara-Hemicyclia* faciation (iii) Manilkara-Chloroxylon-Eugenia-Vitex faciation
Low jungle	..*Subclimax*	*Manilkara-Hemicyclia-Pterospermum-Randia* associes
Scrub types	*Subseres*	(i) *Hemicyclia-Pterospermum-Manilkara-Bauhinia, &c.* (a very variable and mixed community) (ii) *Hemicyclia-Cassia-Euphorbia* desert scrub (iii) *Acacia* thorn scrub
	Serclimaxes : ..	(i) *Rhizophora* consocies
	Mangrove type ..	(ii) *Avicennia* consocies
	Sand dune type ..	(i) *Spinifex-Ipomaea-Scaevola* associes
	Disclimaxes : ..	(i) *Andropogon* consocies
	Low grassland type (" *Damanas* ")	(ii) *Imperata* consocies

II.—WET EVERGREEN FOREST CLIMAX

High forest type	*Climax Associations* ..	1. *Dipterocarpus* consociation 2. *Mesua-Doona* association
	Faciation of 2 ..	*Durio-Doona-Palaquium-Myristica* faciation
	Lociation of 1 ..	*Camnosperma* lociation
	Sub-climax	*Vitex-Wormia-Chaetocarpus-Anisophyllea-*(*Dillenia*) associes
	Facies of above	(i) *Myristica-Semecarpus-Mangifera* facies
Sub-coastal forest ..	.. ..	(ii) *Del-Syzygium-Chactocarpus, &c.*
Low jungle types	*Sub-seres*	(i) *Aporosa-Chaetocarpus-Vitex-Anisophyllea* associes (ii) *Humboldtia* consocies
Scrub jungle type	also *Disclimaxes* ..	(iii) *Macaranga-Trema-Wendlandia-Ochlanda* associes (iv) *Hedyotis-Melastoma-Osbeckia* associes (v) *Gleichenia* (fernland) consocies (vi) Grassland associes (*Themeda-Cyperus, &c., Cymbopogon* or *Imperata* consocies)
	Serclimaxes as for the Dry Mixed Evergreen Climax	

ECOTONE—INTERMEDIATE WET EVERGREEN FOREST

High forest	*Artocarpus-Vitex-Filicium-Pterospermum-Nephelium* community (sub-climax ?)

MINOR CLIMAXES

III.—MONTANE TEMPERATE (SUB-TROPICAL) EVERGREEN FOREST CLIMAX.

High forest ..	*Climax Association* ..	*Syzygium-Calophyllum-Gordonia-Michelia* association
Low jungle ..	*Sub-climax* ..	*Syzygium-Litsea-Semecarpus, &c.*
Scrub ..	*Subsere*	*Hedyotis-Strobilanthes-Osbeckia, &c.*
Grassland ..	*Preclimax* (or *Disclimax*)	(i) *Chrysopogon-Pollinia-Arundinella-*(*Rhododendron*) associes
	facies ..	(ii) *Garnotia-Eriocaulon-Cyperus* facies

IV.—MONTANE " DRY " GRASSLAND (DRY PATANA) CLIMAX

	Climax Association ..	*Themeda-Arundinella-Pollinia, &c.* association
	faciation ..	Shrub complex (*Microglossa-Osyris-Lantana, &c.*) *Cymbopogon-Pteridium* faciation
Riparian forest	..*Postclimax*	*Syzygium-Neolitsea-Litsea-Michelia-Symplocos* association

ECOTONE—TROPICAL SAVANNAH

Low tree-grass	..*Associes*	*Anogeissus-Careya-Terminalia-Phyllanthus, &c.* (low trees) +*Cymbopogon-Imperata* (grasses)
Grassland	..*Disclimax* ..	*Cymbopogon and Imperata* low-grasslands

Photo. 15.—Pattipola-Ambawela Proposed Reserve in Nuwara Eliya District, altitude 6,200–7,000 ft. A general view of the forest climax–Syzygium–Calophyllum–Gordonia–Michelia association. The stunted growth and spreading crowns of the trees are clearly observed.

Photo. 16.—Pattipola-Ambawela Proposed Reserve in the Nuwara Eliya District. Montane grassland (wet *patana*) preclimax in the foreground, the Chrysopogon–Pollinia–Arundinella associes (with Rhododendron zeylanicum Booth) both in the near foreground and slopes. The swampy central portion is characterized by the Garnotia-Eriocaulon–Cyperus facies. In the background is the montane forest.

Photo. 17.—Horton Plains in the Nuwara Eliya District (7,000–7,300 ft.). An example of the montane grassland (wet *patana*) type with the swamp facies Garnotia–Eriocaulon–Cyperus predominant on the relatively flat sections. The stunted trees on the left foreground are Rhododendron zeylanicum Booth.

MONTANE "DRY" GRASSLAND (DRY *PATANA*) TYPES

Photo. 18.—A general view of the montane grassland and forest between Pattipola and Errebedde in the Nuwara Eliya District. In the foreground is the dry *patana* Themeda–Arundinella–Pollinia, &c., association. The ridge in the background (5,000–6,000 ft.) marks the ecotone between montane grassland and forest.

Photo. 19.—Dry *Patana* at Diyatalawa in Badulla District (4,500 ft.). In the foreground is the shrub complex (Microglossa–Osyris–Lantana, &c.)–Cymbopogon (*mana* grass)–Pteridium (bracken fern) faciation and on the upper slopes, the typical Themeda–Arundinella–Pollinia, &c., association.

Photo. 20.—Errebedde Reserve in Badulla District (4,200–4,500 ft.), showing the riparian forest postclimax, the Syzygium–Neolitsea–Litsea–Michelia–Symplocos association; the shrub–*mana*–bracken faciation is observed in the foreground. A plantation of exotics is to be seen in the top background.

REFERENCES

1. Warming, E.—Lehrbuch der ökologischen Pflanzengeographie (1896). (English edition —The Oecology of Plants—1909).

2. Schimper, A. F. W.—Pflanzengeographie auf physiologischer Grundlage, 1898 (English translation—1903).

3. Clements, F. E.—(selected works) Plants Succession—1903. The Relict Method in Dynamic Ecology, *Journal of Ecology*, 22, 1934. Nature and Structure of the Climax, *Journal of Ecology*, 24, 1936.

4. Phillips, J.—Succession, Development, the Climax and Complex Organism, an analysis of concepts, *Journal of Ecology*, 22, 1934 and 23, 1935.

5. Bourne, R.—Some Ecological Conceptions, *Empire Forestry Journal*, 13, 1934.

6. Tansley, A. G.—(selected works).—The Classification of Vegetation and the Concept of Development, *Journal of Ecology*, 8, 1920. Practical Plant Ecology, 1923. Introduction to Plant Ecology, 1946.

7. Bor, N. L.—A Glossary of Terms used in Plant Ecology, *Indian Forest Records*, Vol. VI, No. 3, 1947.

8. Watt, A. S.—Pattern and Process in the Plant Community, *Journal of Ecology* 35, 1947.

9. Morrison, C. G. T., Hoyle, A. C. and Hope-Simpson, J. F.—Tropical Soil Vegetation Catenas and Mosaics, *Journal of Ecology*, 36, 1948.

10. Milne, G.—Some suggested Units for Classification and Mapping particularly for East African Soils, *Soil Research, Berl.*, 4, 1935.

11. Cajander, A. K.—Theory of Forest Types (English translation), *Acta Forestalia Fennica*, 1926.

12. Joachim, A. W. R.—A Review of Progress in the Study of the Soils of Ceylon—Proceedings of the Ceylon Association of Science, First Annual Sessions, 1945.

13. Chapman, V. J.—The Application of Aerial Photography to Ecology as exemplified by the Natural Vegetation of Ceylon, *Indian Forester*, 73, 1947.

14. de Rosayro, R. A.—The Soils and Ecology of the Wet Evergreen Forests of Ceylon, *Tropical Agriculturist* 98, 1943.

15. Holmes, C. H.—Some Forestry problems in Ceylon and the search for their solution, Proceedings of the Ceylon Association of Science, Fourth Annual Sessions, 1949.

16. de Rosayro, R. A. The Montane Grasslands (Patanas) of Ceylon, an Ecological Study with reference to afforestation, *Tropical Agriculturist*, 101, 1945 and 102, 1946.

Patana Fires in Estates and Water Catchments

BY
R. MACLAGAN GORRIE
SOIL CONSERVATION OFFICER

IN spite of many resolutions of committees in the past and individual efforts of owners, the control of grass fires in patana lands has proved to be a hopeless task so long as *illuk* and *mana* grasses provide the main plant cover. The amount of damage done to tea and rubber by the concentrated erosion from recently burnt patana land uphill above the plantation constitutes a serious problem. Every fire exposes a fresh earth surface which is immediately washed down the main drainage channels, gouging them out to greater depths, or flooding across the top road to erode the crop itself. Frequently tea bushes and rubber trees are actually destroyed by fire, but this direct damage is only a very small item of loss compared with the resultant erosion.

As a result of visits to a large number of estates, I am convinced that many individual owners and superintendents would be prepared to tackle the patana fire problem if they thought they had any hope of success, but there is a general atmosphere of defeatism on this subject, due largely, I think to the complete failure of control measures on public *patana* lands. Private owners feel that the problem is beyond them and that they cannot keep fire out of their own patana blocks.

As long as *illuk* and *mana* are the main plant cover this is true. So our problem is to replace these by something less inflammable at a cost per acre which the management would consider as justifiable expenditure for the area which directly concerns them.

It does not require complete afforestation to subdue these grasses but it does need a change in what the Botanists call *ecological progression.* These grasses are only a climax or final product as long as fire occurs annually and no other plant can do any better, but a trench and ridge dug truly along the contour will trap sufficient water to allow other things to grow. The plants most likely to conquer the patana grasses and replace them are trees, not other grasses. Few of the local native trees are of much use as pioneers, so we have to try foreign importations. For the hotter and lower grasslands the best choice probably is *Leucaena glauca* and for land in the mist belt or any where above 3,500 ft. *Acacia decurrens.* The latter tree has shown a remarkable capacity to seed itself in burnt patana in the neighbourhood of Ohiya and Hakgala. For middle elevations and land not too badly eroded, *Alstonia scholaris* should give good results as it has already done in the Hantanne patana at the head of the Kandy Municipal Water Catchment at about 2,200 ft. up to 3,000 ft. The Reserve of Uda-

wattakele immediately above Kandy town contains profuse natural seeding of this tree. Lantana and another much detested weed *Clusia rosea* (Jamican balsam or wild fig) might have their uses as a means of subduing the patana grasses in the middle elevations but they are useless things and once they take charge it might be difficult to replace them by anything more useful.

Economically the chief justification for afforesting patana lands is for fuel supply, and for this purpose both *Alstonia* and *Acacia decurrens* are good because they coppice freely and can therefore be cut over on a short rotation of 6 or 8 years in firewood coupes without exposing the soil unduly. The proposal therefore is that individual owners or companies who have blocks of patana in their own keeping should dig contour trenches 30 to 35 feet apart. Trenches should be 1½ ft. deep and 2 ft. wide at the bottom with the soil built up into a broad flat berm on the downhill side of the trench. The length is immaterial and rock surfaces should of course be left. Cross blocks or soil should be left in the trench every 10 to 12 feet to stop the water from slopping over in case mistakes in alignment take the line off the contour. Sowing or planting should not be done until the trench system has been tested by a heavy shower and weak and low points repaired. Sowings or transplants should be placed towards the top of the berm so that the young plants do not get drowned.

I should be glad to hear from any planter who has attempted any such work in patana land or who wants advice on this problem.

Departmental Notes and News

I. PADDY PURCHASES AND MILLING OUTTURNS

When the rice miller purchases paddy and when the farmer sells it there are two parties whose interests are opposed and must be reconciled or at least placed on a stable and acceptable basis. The normal trading risks attendant on every marketing transaction have to be paid for with the result that the buyer adjusts his price to cover the risks he takes. If these trading risks are large or very variable the seller must suffer in the long run even though for a short time or on isolated occasions he may be the gainer.

Rice millers must adjust the price they pay for the paddy they mill according to the expected sale price of the rice, the costs of milling, the expected outturn of rice from a given quantity of paddy, the milling outturn, interest, handling, storing and other incidentals to their business. One of the greatest and most constantly changing variable in their business is the milling outturn. This is influenced by the variety of paddy, the degree of mixing or purity, the moisture content, age and, above all, the quantity of chaff, empty grain and rubbish which each consignment contains. For standard varieties of reasonable purity the miller knows by experience how much rice it will yield and he is generally able to judge its water content within limits. He knows that the farmer will sell damp paddy if he can : that is, he will attempt to sell water at the price of paddy. The quantity of chaff and empty grains is less easily judged with sufficient accuracy when large quantities are handled and to overcome this a system of weight-cum-volume buying has been adopted in the big rice markets of Asia where millions of tons have to be handled each season.

The interests of two parties are concerned : the miller must protect himself against paying for worthless grain while the farmer or paddy trader must receive a fair price according to the quality of his produce and the care he has taken to prepare it for market by good winnowing. It is obviously unfair to pay the same price for badly winnowed grain as for a well winnowed sample. A flat rate for paddy irrespective of quality or freedom from rubbish induces the growing of high yielding varieties, which fill the bushel measure but may be of poor milling quality. Under normal trading conditions price adjustments are made for varieties and for their real value as precursors of rice.

The current Ceylon practice is to take a bushel of 46 pounds as standard and the Government guaranteed price of Rs. 8 per bushel irrespective of any other characters the sample may have. All paddy is treated alike

no matter what its milling outturn or eating quality. In order to reach a bushel weight of 46 pounds the grain must be very well winnowed and almost free from empties or else it must be watered. There are, in fact, some varieties which will never give a 46-pound bushel weight even if perfectly winnowed unless the moisture content is well above the optimum storage and milling figure of 11-12 per cent. This inevitably leads to difficulties in the purchase of paddy which is generally delivered at the mill in a condition some degree below the standard. With the primitive winnowing facilities available it is often difficult for the farmer to reach the 46-pound figure and he always hopes to get away with some chaff, and so on. At the same time the mill manager must protect himself but the tendency is to carry the protection too far and cheat the farmer. It is for the purpose of lessening the millers' risks while giving the farmer a fair deal and also putting a premium on good samples to encourage them that the system of poundage allowance has been devised.

As a result of many years trials involving millions of tons of paddy each year the rice markets of Rangoon and Bangkok have found that an allowance of $2\frac{1}{2}$ per cent. for each pound above or below the standard at which the price is fixed compensated the miller for any lowered rice outturn and adequately rewards the seller for higher outturn. The poundage allowance for bushel weight then works as in the following examples :—

(1) If A delivers 100 bushels of paddy having a bushel weight of 46 pounds and the standard price for a 46-pound bushel is Rs. 8 he is paid by the miller Rs. 800.

(2) If B delivers 100 bushels of paddy having a bushel weight of 48 pounds the mill will pay $2\frac{1}{2}$ per cent. extra for each pound over the standard of 46 pounds, i.e., $2\frac{1}{2} \times 2 = 5$ per cent. in this case. Five per cent. on 100 bushels is 5 bushels and B will be paid as if his consignment was 105 bushels and not 100. That is, he will be paid 105×8 or Rs. 840.

(3) If C delivers 100 bushels of paddy having a bushel weight of 44 pounds he would receive a cut of $2\frac{1}{2}$ per cent. on each pound under the 46 pound standard and would be paid as if he delivered $100 - 5 = 95$ bushels or $95 \times 8 =$ Rs. 760.

It is important to note what the effect would be if payment were made only on weight, without considering volume. Thus if B's paddy is bought on a weight alone basis he would get $100 \times 8 \times \frac{48}{46} =$ Rs. 834.78 or Rs. 5.22 less than he gets under the weight-cum-volume system. In the case of C his paddy weighs $4{,}600 - 4{,}400 = 200$ pounds less than the standard and 200 pounds at Rs. 8 per 46 pounds is Rs. 34.78 so that he would be paid $800 - 34.78 =$ Rs. 765.22, gaining Rs. 5.22 by the weight-alone system.

The weight-cum-volume system has the indirect effect of grading and since bushel weight is highly correlated with rice outturn in the mill, it

protects both miller and seller but it penalizes those delivering badly prepared samples while rewarding the good farmer. The following Table shows the paddy prices according to bushel weights :—

TABLE I

Paddy prices according to Bushel Weight

Standard Weight = 46 pounds per bushel

Bushel weight lb.	*Price based on 2½ per cent poundage allowance*	*Price based $\frac{800}{46}$ or 17·39 cents per lb.*	*Price based on 20 cents per pound allowance over or under this standard bushel weight when the price is Rs. 8 per bushel*
	Rs. c.	*Rs. c.*	*Rs. c.*
49	8 60	8 52	8 60
48	8 40	8 35	8 40
47	8 20	8 17	8 20
46	*8 0*	*8 0*	*8 0*
45	7 80	7 83	7 80
44	7 60	7 65	7 60
43	7 40	7 48	7 40
42	7 20	7 30	7 20
41	7 0	7 13	7 0
40	6 80	6 96	6 80

When the 2½ per cent. poundage allowance is given the seller who delivers overweight paddy is paid for the extra poundage at a slightly higher rate than if the exact price per pound of 17.39 cents was taken. The seller who delivers underweight paddy is paid at a slightly lower rate. For example at 45 lb. per bushel he drops 2.61 cents per bushel.

At a fixed price of Rs. 8 per bushel a 20-cent allowance per pound bushel weight equals the 2½ per cent. poundage allowance but this does not hold for other prices. So long as all paddy is bought at one price irrespective of variety, purity, season, place, and so on, a fixed money allowance is convenient but if the buying is more discriminatory the 2½ per cent. allowance is preferable because it applies automatically to all prices.

Though the bushel weight is closely related to the quantity of milled rice a sample can give, there are other factors which must be allowed for fixing a fair price to the miller and the grower. If the variety is white, such as *Podiwi* admixture of red grain detracts from its commercial value and a mixture of varieties of different sizes of grain causes higher milling costs. The miller must therefore take these factors into account when buying and it is usual to fix the basic price first giving due consideration to such points and then apply the poundage allowance when the bulk is delivered by drawing periodical samples in the presence of the seller and the buyer and from these calculating an average bushel weight. So long as there is a minimum guaranteed price which does not define the quality or grade beyond the 46-lb. bushel weight the compulsory buyer is at a disadvantage and is practically forced to apply devices in order to protect himself against milling losses. These are ultimately passed on to the grower who may be the loser. Unless there is some clearly defined and understood system on which prices are fixed there must grow up expedients and juggling with weights, measures and allowances which, by reason of the elusiveness, constitute a serious factor in increasing trading risks with all their attendant evils recoiling ultimately on the primary producer.

II. AN IMPROVED YOKE

In any ploughing or other cultivation operation it is the intelligence of the man and not the will of an animal which must prevail if the work is to be well done. The customary method of driving a buffalo or bullock without reins or nose string and only a single yoke pin allows the animal to zig-zag about all over the field with the ploughman hanging on behind as best he can. The ground is not systematically covered and there is much waste of effort.

An improved yoke now tried for two seasons uses double yoke pins longer than customary in Ceylon. This allows of a very simple and easy hitch for the animals without trying them tightly. Animals can be yoked and unyoked easily and quickly without troublesome knots. The yoke is simple to make and requires no metal parts. It is easier to control the animals with reins fastened to the nose string on the top of the head. It is not suitable where *liyaddas* are narrow or the land steeply terraced. The pins can be made of hard wood and should be long enough to project about one foot above the yoke pole and then 9-10 inches below it.

Many of the departmental farms have now adopted this yoke which gives better control and lessens work. It is specially valuable for dry farming operations where line cultivation is essential.

III. POTASH DEFICIENCY IN PADDY SOILS

In *Maha* 1949-50 widespread symptoms of potash deficiency appeared in scattered areas in the low country wet zone. The symptoms are a dark green colour of the leaves soon followed by a bronze discolouration of the tips of the leaves and bronze spotting. The roots of affected plants are generally a dirty grey colour and unhealthy. The deficiency has been particularly noticeable on fields which received a phosphatic dressing (bonemeal, ammophos or superphosphate). Applications of muriate of potash caused a rapid response and disappearance of the leaf symptoms if not given too late in the growing season.

In the low country wet zone it is to be expected that dressings of potash fertilizers (muriate of potash, wood ash or citronella ash) will frequently give good responses, particularly if used in combination with phosphates.

IV. FOOT-AND-MOUTH DISEASE

Work in collaboration with the Danish Institute at Copenhagen has shown that one type of Foot-and-Mouth virus occurring in Ceylon is Type O. Others may also be present.

V. HARROWING THE STANDING PADDY CROP

The practice of harrowing the standing paddy crop when 3-5 weeks old gives substantial yield increases but it is often hard to induce farmers to carry out this simple operation. At first they fear it will damage their crops. The following are quotations from an Agricultural Officer's diary :—

> " . . . . visited Andamkulam. The harrowed fields were much greener and of better growth than the adjacent fields. The cultivators themselves were impressed by the difference in growth."

" Harrowing of the standing crop of paddy is a new paddy operation which the cultivators are very reluctant to adopt. One cultivator said that it was something like allowing his children to be cut with knives. He further said that it was very annoying to him to allow a pair of bulls into his fields after he had very carefully fenced them. Another demanded in writing an assurance that his crop would not be damaged by this operation. "

" In the whole blocks cultivators resisted any attempt to introduce improved methods of cultivation. "

" Visited A. Kandiah's fields. In 1949 *Yala* this cultivator harrowed his paddy fields and obtained a yield of 65 bushels per acre as against 40 bushels in the adjoining fields. "

The advantages of this treatment were shown by Wickramasekera in 1940 and it is standard practice in parts of India. It is still an uphill task to get it adopted in Ceylon.

VI. BUPRESTID ATTACKING STYLOSANTHES

A fairly severe attack occurred in June 1949 on several species of *Stylosanthes*, including *S. gracilis*, being tested at Pelwehera Farm. The insect has been identified by the Entomologist as *Sphanoptera perroteti*. This beetle was recorded 40 years ago on *Tephrosia* at Trincomalee and has remained a rarity since then. Following a long dry spell it assumed the proportions of a pest on *Stylosanthes* at Pelwehera. It is known to attack other legumes such as cowpea, gram, groundnut, *Cassia*, Crotalaria, &c., in South India. The grub of the beetle bores into the main stem of the plant near ground level, devours the root and frequently causes the death of the plant.

VII. TEA SMALL HOLDINGS

With the co-operation of the Tea Research Institute the Department of Agriculture has started a scheme to supply germinated tea seed to small holders at low prices. It is hoped by this means to encourage the filling of vacancies on small holders tea land which, in many cases, is subject to serious soil erosion. This erosion is largely due to the many gaps in the stand of tea bushes. It is also hoped to improve the yield of tea per acre and ultimately to reduce the thefts of tea seedlings from large estate nurseries, which have assumed serious proportions in some areas.

VIII. WATER REQUIREMENT OF PADDY

An experiment done by the D. A. O., N.-C.D., (Mr. Karunaratne) at Hingurakgoda Farm during *Yala* 1949 to measure the irrigation water needed for the paddy crop showed that a total of 2.23 acre-feet of irrigation were used in addition to the rainfall of 7.65 inches, or a total water supply of less than 3 acre-feet. This contrasts with the 7-10 acre-feet or more that the cultivators claim is needed.

IX. CAMPAIGN TO CONSERVE CATTLE MANURE

In parts of the Island little attention is paid to the conservation of cattle manure, much of it being wasted. The results of collecting cattle

manure and applying it to the paddy fields in part of the N.-C.D. in *Maha* 1949-50 were so striking that the District Agricultural Committee has decided on an extensive drive covering 270 villages in *Maha* 1950-51. A sum of Rs. 30,000 has been set aside which will be awarded to those villagers collecting manure and applying it to the fields. The rate paid will be two cents per basket awarded in the form of Savings Certificates. Competitors will be required to collect good quality manure into heaps which will be assessed by a responsible officer of the Agricultural Department before awards are made. It is hoped in this way to encourage conservation of much of the cattle manure now being scattered and wasted.

X. HAY MEAL FOR POULTRY

Thornless Mimosa (*Aeschynomene americana*) has been found to yield an excellent hay meal for poultry feeding. The broadcasted crop gives several cuttings of green fodder a year at Peradeniya. The green cuttings can be quickly turned into hay by sun drying. It is then put through a hammer mill and reduced to a meal which can be stored. Analysis of lucerne and thornless mimosa meal prepared at the Experimental Station, Peradeniya, are given below with an English lucerne sample for comparison.

Composition	*Peradeniya Samples*		*English Lucerne (Analysed by Holnan)*
	Lucerne	*Thornless mimosa*	
	per cent.	*per cent.*	*per cent.*
Moisture	15·3	12·7	16·0
Protein	18·2	21·3	16·2
Ash	7·8	7·7	7·3
Fibre	21·5	22·6	27·0

The Late Mr. F. P. Jepson, M.A. (Cantab.) Dip. Agric. (Wye).

NEWS has been received with regret of the death in Surrey, England, on May 14 of Mr. F. P. Jepson, late Deputy Director of Agriculture, Ceylon. Mr. Jepson arrived in the Island in June 1919 to take up the appointment of Assistant Entomologist, Department of Agriculture. He had previously served in the Department of Agriculture, Fiji, as Government Entomologist since 1909, and his work there had been greatly appreciated both by agriculturists and the Government.

During the 13 years of his service in Ceylon as Assistant Entomologist, Mr. Jepson made numerous contributions to the solution of problems dealing with the control of pests affecting the major economic crop of the Island, viz., tea. Chief among these is his work on the Shothole borer of tea (*Xyleborus fornicatus*) and on tea termites (*Calotermes* spp). His work on tea termites led him to a fundamental study of other species of termites and of their control. His investigations on the control of termites attacking buildings were of great practical value, and his recommendations were adopted extensively not only in Ceylon but abroad as well. He also worked out a simple method for the control of mound-building termites which resulted in a considerable saving of expenditure in the removal of these unsightly structures All this Mr. Jepson was able to achieve because he was a highly conscientious, painstaking and indefatigable worker who kept abreast of all developments in his subject and was able to secure the active co-operation of all those he came in contact with, whether brother officers, assistants or the agricultural community.

In 1932, with the reorganization of the Department, Mr. Jepson was appointed to the newly-created post of Controller of Plant Pests. The new post involved the administrative control of water-hyacinth and of the declared pests under the Plant Protection Ordinance. To his new duties Mr. Jepson brought the same zeal, organizing ability and single-mindedness of purpose as was characteristic of his work as Assistant Entomologist. The result was as to be expected. The water-hyacinth which had assumed serious proportions in certain tanks and waterways of the Island, was being steadily eradicated, and when he gave up the post of Controller of Plant Pests in 1936 to assume the more onerous responsibilities of Deputy Director of Agriculture, the weed had become fully under control.

In the post of Deputy Director of Agriculture, of which he was the first occupant, he was a tower of strength to the Director who at the time was a Civil Servant. He worked almost incessantly, giving his best even to the detriment of his health, and in 1940 was compelled to resign as his health had failed. Thus ended his career of 21 years in the Department of Agriculture, every phase of which was characterized by a high sense of duty, untiring energy, and productive activity.

But it was even more for his personal qualities than for his technical ability that Mr. Jepson will be remembered. Of a friendly and unassuming disposition, he was the essence of loyalty to his superiors, a guide and friend to his subordinates, a sound and unfailing adviser to the agricultural community, and a gentleman in every sense of the word. His memory will long remain fresh in the minds of all those who have had the privilege of knowing him.

A. W. R. J.

Soil Conservation

PUBLIC statements on soil erosion during 1949 tended to avoid extravagant stories of the amount of damage being done and to concentrate upon the more constructive view of what had been and was being achieved to counterbalance the known losses from sheet erosion and gullying due to water action and from erosion by wind. The direct connection between the loss of cultivable land through gullying, decrease in productivity of cultivated land through sheet erosion and formation of shifting sand dunes and the world's food supply was, however, stressed. Out of a total land area of 35,700 million ac. less than 4,000 million, or about 10 per cent. of the whole, was actually cultivated and this again was allocated partly to industrial crops so that the food producing area averaged 1½ ac. per head of world population. Given yields similar to those of Great Britain this would be enough, but the average in most countries was very much less. Thus, with spectacular increases in their population, Asia and Africa faced increasingly heavy deficits of wheat and rice. Every country would have to try to stop erosion losses, make existing fields more productive and bring into some form of production land now lying idle.

In most countries of Asia and Africa marginal land was being ruined, not by ploughing, but by over-grazing by useless village herds. India possessed 300 million head of cattle out of which at least 80 million were surplus and formed a heavy drain upon available fodder. An even worse burden was the huge herds of goats which were largely responsible for the desiccation and spread of desert conditions in India, Pakistan, Baluchistan, Iraq, Persia and many parts of Africa. As this type of land was more used for grazing or ranching than for field crops, the study of grassland improvement was being taken up in many countries. In South Africa over 100 types of veldt were recognized. Crested wheat grass originating in the U. S. S. R. was now widely used in Canada and the United States. Australia took grasses from many other countries to build up suitable strains by selection and cross-breeding, but lack of seed in many arid grasses was a handicap. The need for a Commonwealth research station to deal with arid and semi-arid grass types was emphasized by Sir John Russel (*q.v.*) in his presidental address to the British Association at Newcastle in September 1949. A great need was for leguminous plants which could serve as pasture improvers in semi-arid conditions in the same way as clover and lucerne had already done for moister regions.

In Australia large tracts of previously infertile land were improved by the application of only a trace of rare soil constituents such as zinc, copper, iodine and boron, to whose absence the infertility was due. Soil barrenness was investigated in the Cawthron Institute, New Zealand, and by the Swedes at Svalof, their plant breeding station in southern Sweden.

The reclamation of badly gullied land by means of bulldozers and similar mechanical equipment was demonstrated in the Rawalpindi uplands of the West Punjab where waste land was reclaimed partly for fields and partly for the afforestation of land too steep to terrace economically. For average slopes terracing cost Rs. 100 an ac. but where the land was very badly gullied or the slope was up to 8 per cent., the cost rose to Rs. 150 or 200 an ac., the Pakistan rupee being worth 9.2 to the £ sterling at the end of 1949. The making of water ponds formed an integral part of this catchment planning because proper field maintenance was apt to be neglected if the plough bullocks had to go far for water in the hot season. Ploughing of fallow between storms was essential if field surfaces were to be kept absorbtive.

The provision of water ponds similarly formed a prominent part in the mechanized land reclamation done by the Overseas Food Corporation in northern Queensland and by the Sudan Plantation Syndicate. The ambitious groundnuts scheme for developing 3,250,000 ac. of savannah land in Kenya and Nyasaland got off to a bad start owing to causes such as lack of machine spares and to cultivation attachments for ploughing and sowing being unsuitable for the jungle clearance which had to be done before crops could be sown. There

was also a danger that complete clearance of jungle vegetation, although an advantage through ensuring freedom from tsetse fly, would eventually lead to serious erosion and desiccation through lack of windbreaks or shelterbelts. The social side of the problem was to provide enough supervision with an expensive and thinly scattered European staff during the interval until enough capable Africans could be found and trained up to hold supervisory posts.

An example of wind erosion was seen in the Mianwali Thal, a desert district of the West Punjab now being opened up with irrigation from the newly finished Daud Khel barrage across the river Indus. The rainfall was about 8 in. and very erratic and unreliable, and for the previous 30 years the old desert scrub jungle which held the sandy surface had been destroyed by opportunist ploughing of the sloping ground to produce an unirrigated crop of gram (*Phaseolus mungo*). As a result the irrigation farmers who included many groups of ex-servicemen were faced with land which was now largely shifting sand dunes of from 3 to 15 ft. high and moved around by every storm. Storms in May 1949 not only blew plants out of the ground but also blew away many of the water channels. The cure for this lay in planting hedges as windbreaks round every holding and thicker belts of trees along the banks of all distribution channels.

The U. S. S. R. had announced in October 1949 a new project in which shelterbelts were to be planted along the lower reaches of the Don, Donets, Volga and Ural rivers as an essential step towards preventing droughts such as had hit the Volga basin 20 times in the previous 63 years. Sandy areas were to be afforested, and crop rotations made compulsory in ploughland. A prominent item was again farm ponds of which 44,000 were planned.

Figures of the erosion incidence in New Zealand were published in the *Geographical Magazine* (London, September, 1949) in which C. R. Stanton showed that a quarter (15,244,000 ac.) of the total country was already suffering in the following proportions: minor land-slips, 3,200,000 ac.; major slips and torrents, 6,163,000 ac.; wind eroded, 4,557,000 ac.; sheet eroded, 1,324,000 ac. The Soil Conservation and Rivers Control Act passed in 1941 worked through local catchment boards which were small groups of officials and non-officials authorized to enforce this law.

Technical knowledge about the way to control erosion was summarized by the United Nations which held a conference on the conservation of natural resources at Lake Success, New York, in August 1949. Papers prepared by British and other workers in the tropical and more backward countries tended to prove that the social and administrative difficulties were much worse than the purely technical problem of stopping erosion. The smallness of individual holdings prevented effective contouring but consolidation of holdings was a lengthy legal process. Collective farming was a difficult matter to introduce amongst primitive or individualistic people who had no previous experience of working on a co-operative principle. Again the local land revenue or taxation authority in charge of village records had no enthusiasm for work which would wreck his own book-keeping system and deprive him of his customary payments. A further difficulty was that common land was nobody's business; the commons in most countries were in poorer condition than they ought to have been, but it was difficult to alter legally admitted grazing rights.

From a technical point of view, it was advisable to tackle each single river from top to bottom of its catchment, starting with the forest protection of the mountain ranges concerned and working downhill to the plains, applying every conceivable remedy no matter to what use the land was being put. In practice national boundaries often defeated this. A notable example of co-ordinated work of this sort was seen in the Rhine Control Commission, under whose direction counter-erosion work had gone ahead in Switzerland and Austria through both World War I and II. The creation of new national boundaries might raise fresh difficulties: for instance the occupation of Kashmir by India might prevent the co-ordination of control in the great Punjab rivers all of which have their catchments in the high Himalayas in and around Kashmir; the Indus, Jhelum, Chenab and Ravi were all affected, and even some of the smaller torrents of Jammu Province of Kashmir are two miles width of sand at the point they enter the West Punjab. Expensive and vital irrigation works are therefore very vulnerable and the drawing of a new political boundary may greatly complicate the administration of water resources.

(R. M. G.).

(Extract from the *Britannica Book of the Year 1949*, published by the Encyclopaedia Britannica, London.)

The Development of Under-Developed Lands

(We reprint below an editorial from the Winter 49-50 issue of the British Agricultural Bulletin. This editorial is written by Professor L. Dudley Stamp of the University of London, Chair of Economic Geography and the organizer of the successful and vitally important Land Utilization Survey of Great Britain.)

World attention is being directed to the under-developed lands of the world in a way in which it has never been before. We are becoming increasingly aware that world increase of population must inevitably mean either increased food supplies or starvation and we inevitably look to those parts of the world, at present under-populated, where the proper use of land can produce a larger output of food. At the same time the peoples of the western world have become increasingly conscious of the large proportion of the world's peoples lacking modern scientific knowledge, implements, capital and skill, who are living at a very low level, indeed on the fringe of starvation. The now famous Point 4 of President Truman's address to Congress in January 1949, records the awakening of American conscience to the problem, whilst Britain's Colonial Development and Welfare Act of 1940 made specific reference to the need for development in her Colonial Empire, and made provision for financial aid to be provided by the British taxpayer.

The immense difficulties which have been encountered by the East African Groundnuts Scheme should serve as a salutary lesson to remind us all that the task of increasing production in tropical lands is far from being an easy one even with all our modern technique. It is probably true to say that there are no longer in the world any large areas of easily developed virgin lands, as there were in those days—a generation or two ago—when the prairies of North America were first turned by the plough or the pampas of the Argentine gave their first crops of wheat. Both for the development of world food supplies and for the raising of the standard of living of the peoples in the areas concerned we need new knowledge before we can develop new techniques for getting new production from new lands.

There are enormous areas in the Tropics, particularly in Africa and South America, which are at present sparsely populated and which produce little for the world's markets. What is the right way to attempt the development of these areas?

In the first place I suggest that it is absolutely essential to carry out a land use survey. The question of organizing a world land use survey was discussed in December last by a Commission which met at Clark University, Worcester, Mass., under the auspices of the International Geographical Union and UNESCO. The Commissioners (of which the writer was one) unanimously recommended that a world-wide attempt should be made to carry out such a factual survey. It aims at recording on the best scale map available the existing use of the land. Expert witnesses who gave evidence before the Commission pointed out again and again how countries may have a well-recognized local system of land rotation or shifting cultivation difficult for an agriculturist trained in temperate or mid-latitudes to understand. Many native peoples have developed techniques of their own for controlling soil erosion. Thus the existing use of the land should be carefully and accurately mapped, and the Commission recommended a series of explanatory memoirs which should analyse the reasons for the existing use (or perhaps absence of use) of land. We do not in many cases know whether it is soil or climate or the prevalence of disease or the absence of population or some other factor, which is responsible for the present position.

Such a factual survey must be a pre-requisite to any question of land planning. Physical planning is essentially either the encouragement of existing trends and use, or the adoption of positive methods to change such trends and use. In any case the land planner does not start with a blank sheet of paper. He starts with a country-side, complex in

many particulars. It is essential to graft any new development so that it will grow naturally and continuously on what is there already, if it is to benefit both the local inhabitant and world supplies.

The classification of land proposed by the Commission is briefly as follows:—

(1) Settlements and associated non-agricultural lands; (2) Horticulture; (3) Tree and other perennial crops; (4) Cropland (*a*) Continual and rotation cropping, (*b*) Land rotation; (5) Improved permanent pasture (managed or enclosed); (6) Unimproved grazing land (*a*) Used, (*b*) Not used; (7) Woodlands (*a*) Dense, (*b*) Open, (*c*) Scrub, (*d*) Swamp forests, (*e*) Cut over or burnt over forest areas, (*f*) Forest with subsidiary cultivation; (8) Swamps and Marshes; (9) Unproductive land.

What is the next stage? The Groundnuts Scheme has surely suggested the importance of pilot experiments, so that the agriculturist needs to get to work before large scale planning is possible. The work carried out by the scientific party under Professor B. S. Platt in the Gambia at Geneiri is an excellent example of what is needed; medical, sociological and agricultural experimentation going on side by side, and three parallel lines at work, (*a*) encouraging the native cultivator, (*b*) co-operating with him, (*c*) independent large scale work. The many problems are thus brought to light. It was shown, for example, in this case that mechanized cultivation could increase the number of groundnuts plants per acre and so raise the overall yield per acre to more than three times that obtained by native hand-cultivation; but the yield per plant remained as low as ever—is the answer the climate, the soil, some deficiency of trace elements? Such are the problems thrown up for detailed investigation by the agriculturist.

Such survey work as outlined above is applicable whatever the stage of development of the country concerned. It is broadly the method of the Land Utilization Survey in Britain, and of the work carried out by the Agricultural Land Service of our Ministry of Agriculture. There is the same need to know the present position and the reasons for it. In the wide open lands of Africa, some parts are virtually untouched. In other parts mistakes have already been made—soil erosion exists, over-stocking of grazing land is obvious. All these will be shown by the Survey.

Perhaps the greatest danger is what may be called the subjective approach. It is scientifically accurate to map and state what is there. It is quite another matter to say what should be there. For example, one may find so-called land use surveys where large areas are picked out and marked "suitable for afforestation," or "suitable for crop-farming." This is the result of judgment too often on inadequate information.

The development of the under-developed lands is a long-term project—twenty, thirty, fifty years ahead—but it is work which must be laid on a firm scientific foundation. More knowledge in all fields is what we need most at the present time.

The World's Food and Britain's Needs

BY

A. M. BASSADONE

Reprinted from " Nature " (165 (1950) 517)

THE Association of Scientific Workers held a conference in London during March 4-5, on " The World's Food and Britain's Needs ". While some speakers provided the technical background of food supply from the land and sea and described the possibilities of pest control and new food preservation, Lord Boyd-Orr, Dr. Julion Huxley and Mr. F. Le Gros Clark gave overall surveys of the problem of supplying food to an ever-increasing world population desiring a rising standard of living. In all cases it was the supply of food which was discussed, not nutritional requirements, which were adequately dealt with in the British Medical Association's report published the day before.

Dr. Huxley started by giving a grim picture of the acceleration in world population, and pointed out that even if the rate of increases were declining (and it is not) there would still be net increases for some time to come. The decreasing population in Great Britain and some other Western European countries which alarmed us before the second world war was a local phenomenon—and even in this area the tendency has since been reversed. We all know of the enormous population increases in the Far East (Formosa has doubled its population in less than thirty years; in 1872 Japan had 32 millions, now there are more than 80 millions), but few of us realize that Egypt has doubled its population during this century, and there are other equally startling figures.

Of the present world population of approximately 2,200 million (contrast 920 million for the year 1800 and only about 545 million for 1650), a half or two-thirds suffer from malnutrition. This means that, even without allowances for further population increases, a big increase in food production is needed. Why has food production not kept up with increases in population? Apart from the ravages of war, Dr. Huxley enumerated several cases of bad husbandry on a national level, such as the excessive free felling in the Lebanon, Yugoslavia and Greece, the cultivation of steep slopes without suitable contouring, and allowing previously irrigated land to go back to arid desert. He said that the soil erosion on Haiti, with its 3½ million inhabitants on 10,000 square miles, must be seen to be believed.

Mr. Le Gros Clark hit hard at those who ask what is the use of saving thousands from malaria and other diseases in order that they may die of hunger. He insisted that nothing could hold back medical science, which is the pacemaker for agricultural science. Agriculture has the problem of increasing output fifty to a hundred times in the next fifty years, and, while medicine could save thousands of lives by sending a small band of trained men to clear an area of, say, malaria, despite the ignorance of the inhabitants themselves, on the other hand agriculture cannot be improved without the active co-operation of millions of backward peasants, " oppressed by all the evils which can oppress them ". These evils must be swept away before we get the model producer we want. What is needed is an Agricultural Revolution changing farming methods and social relationships as profoundly as the Industrial Revolution changed our lives a hundred and fifty years ago.

In the opinion of Dr. Bunting, Chief Scientific Officer of the Overseas Food Corporation, what is perfectly possible technically is impossible socially, but Lord Boyd-Orr (whose address was read in his absence through illness) stressed that " there can be no social contentment or peace in the world so long as the majority of the people lack food and believe that under a new order they can get it ".

Not only must the backward peasant be educated, but also the industrial worker must learn to play his part more fully. In his summing up on the second day of the conference, Mr. Le Gros Clark suggested to the delegate from the United Nations Educational, Scientific and Cultural Organization (Mr. M. Goldsmith) that what is needed is not so much information about agricultural methods in different countries as stimulation of the industrial workers (90 per cent. of the population of Great Britain) to consider better their possible contributions towards the improvement of methods and machinery of agriculture. This would not only be in the interests of agricultural communities, but also in our own. Despite the record of famines in India over the centuries, if India and Great Britain were both forced to stop importing food, the Indians would survive longer than we should.

Sunday morning was devoted to the specific problems of improving food production in Britain and of preventing loss of food through pest infestation.

Sir George Stapledon said it is foolish for us to let our wheat acreage fall below the three million mark and asserted that the East Anglian countries did not produce the wheat they should, even at the height of war-time effort. However, he warned, farming to the hilt depends on our obtaining sufficient phosphates and potash.

Dr. G. A. Reay, in talking on fish utilization (he was concerned only with marine fish and made no reference to freshwater fish), pointed out that freezing white fish at sea would mean a considerable saving of steaming time for boats, which often have to return half-empty in order that the fish already caught should not lose its freshness before consumption. Development of freezing plant would also help the canning of fish, as it would enable a constant supply of fish to be available, for no canning factory can work profitably if it only receives seasonal supplies.

Mr. S. A. Barnett, who is head of a research unit on mammalian pests in the Ministry of Agriculture and Fisheries, emphasized that for efficient pest control not only must the scientific worker study the natural history, that is, the life-cycle, habits, &c., of the pest, but also there must be an informed public. It is no use setting traps for rats in India while the Indians go round the traps releasing the caught rats. Not only co-operation between the scientific worker and the public is necessary, but also for many pests international control is essential. International study and control have already proved effective in combating the African red locust and the Colorado beetle, and are under way for the periodic plagues of field mice which occur in Europe and the Soviet Union.

The discussion after the main speeches was more concerned with the politico-ethical/social aspects than with purely technical problems. But the main speakers asked that various lines of research should be undertaken. Sir George Stapledon wanted research on the differential extraction power of different plants on different soils, regarding essential chemicals; Dr. Reay wanted engineers to tackle the problems connected with freezing fish at sea, and, finally, Mr. Le Gros Clark asked for a real study of the " natural history " of famines. There are too many people willing to sacrifice themselves and their money on relieving famines which have already got out of hand, and there is not enough research into what leads up to a famine situation.

Lord Boyd-Orr appeared in Paul Rotha's film, " The World is Rich ", which was shown at the opening of the proceedings, and Dr. D. McClean, of the Lister Institute, read the address he had prepared. He described how food shortages in the past have been responsible for revolutions and described how, in our day, the revolt against hunger and poverty in Asia has produced the most pressing political problem, but, " in a same world ", the enormous surpluses accumulating in one part of the world and the scarcity of food encouraging revolt in other parts should cancel out.

Can we ensure that this world of ours is sane? The world food plan of the Food and Agriculture Organization to double world food production in twenty-five years was put forward in 1946, but the world has not taken sufficient heed of it yet, and the end of Boyd-Orr's speech is worth quoting in full:

" The doubling of world food production would call for an enormous volume of industrial products, many schemes like the T. V. A. plans to stop soil erosion and recondition wastage soils, tractors and farm implements and vast quantities of consumer goods for the agricultural population. These constitute 65 per cent. of the gainfully employed people of the world. With an assured market at a price at or near parity with

industrial products, the purchasing power of food producers would be more than doubled. To carry out such a plan would require credits to countries to enable them to purchase the industrial equipment and to provide a world fund to ensure that everything produced could be sold. The World Bank was set up for that very purpose. If all nations were willing to co-operate in a great scheme of this kind of development of the potential resources of the earth and contribute to an international fund in proportion to their wealth, those having no money putting in an I. O. U. which would be honoured when their natural resources were developed, the world would be well on the way to the abolition of hunger, poverty and preventable diseases and to agricultural and economic prosperity with a doubling and redoubling of world trade. And most important of all, if the nations co-operated on definite concrete plans of benefit to all, the idealogical differences which separate nations would in time lose their significance."

PROCEEDINGS OF THE SIXTH MEETING OF THE CENTRAL BOARD OF AGRICULTURE HELD AT GAL OYA ON MAY 27, 1950, AT 1.45 P.M.

Mr. D. Rhind, Director of Agriculture, presided, and the following were present:—Mr. W. M. Cumaraswamy; Mr. P. B. Bandaranayake; Mr. S. L. B. Dharmakirti, J.P.; A. E. Madawala Dissawa; Mr. A. Hensman; Mr. R. Singleton Salmon; Mr. Marcus S. Rockwood; Mr. R. T. Chelliah; Major E. C. de Fonseka, M.B.E., E.D.; Senator Justin Kotalawala; Mr. S. A. I. Elapata, M.B.E., J.P., U.M.; Mr. Chas. A. M. de Silva; Gate Mudaliyar M. S. Kariapper, M.P., J. P., U.M.; Dr. W. R. C. Paul, Principal, School of Agriculture, Peradeniya; Mr. S. C. Fernando, Registrar of Co-operative Societies; Mr. A. L. Johnpulle, Divisional Agricultural Officer, Uva; Sir James P. Obeysekera; Mr. K. W. Devanayagam; and Mr. H. E. S. Ranasinghe, C.C.S., Secretary, Central Board of Agriculture.

Letters and telegrams regretting inability to attend the meeting were received from the following members:—

Hon. Mr. H. W. Amarasuriya, Minister of Commerce and Trade; Director, Tea Research Institute; Director, Coconut Research Scheme; Mr. R. H. Spencer-Schrader; Mr. E. Abeyratne, Agricultural Research Officer, Maha Illuppalama; P. B. Bulankulama Dissawa, M.P. and Parliamentary Secretary to the Ministry of Agriculture and Lands; Conservator of Forests; Rev. Fr. L. W. Wickremasinghe, Land Commissioner; Mr. U. B. Dedigama; Dr. M. F. Chandraratne, Botanist and Senior Research Officer; Director of Irrigation; Commissioner, Development of Marketing; Senator C. Wijesinghe; Senator (Col.) T. Y. Wright; Director, Rubber Research Scheme; Mr. P. B. Tennakoon; Mr. E. Mutukumaru; Director, Rural Development; Mr. A. M. Clement Dias; Mr. A. Perumynar; Mr. H. Abeygoonesekera; Mr. U. B. Unamboowe; Mr. Wilmot A. Perera, M.P.; Mr. Thomas Amarasuriya, Chairman, L.C.P.A.

The Chairman and the members who attended the meeting, assembled at the Irrigation Office, Gal Oya, at about 11 a.m., and were met by the Resident Engineer who had kindly made arrangements for some of his officials to conduct the party round the construction area. All points of interest were shown and explained to the members present. Thereafter the members and the guests repaired to the Club House where they were entertained to lunch by Gate Mudaliyar Kariapper. After lunch the following formal proceedings were gone through:—

CONFIRMATION OF THE MINUTES OF THE PREVIOUS MEETING

The Chairman proposed that the minutes of the previous meeting be accepted as a correct record of the proceedings and Mr. A. Hensman seconded. The minutes were then unanimously confirmed by the House.

Due to lack of time no other business was transacted and the following votes of thanks were moved:—

(*a*) Senator Justin Kotalawala proposed a vote of thanks to Gate Mudaliyar Kariapper for entertaining the members to lunch and for the efficient arrangements he had made.

Mr. R. Singleton Salmon seconded. Carried unanimously.

(*b*) Sir James P. Obeysekera proposed a vote of thanks to the officers of the Irrigation Department for the excellent arrangements made to show the members round the Scheme.

Mr. S. A. I. Elapata seconded. Carried unanimously.

(*c*) The meeting terminated at about 2 p.m. with a vote of thanks to the Chair proposed by Mr. C. A. M. de Silva.

H. E. S. Ranasinghe,
Secretary, Central Board of Agriculture.

Peradeniya, June 6, 1950.

Tea Research Institute (Ceylon)

MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON, THE LAWN, 113, STEUART PLACE, COLPETTY, COLOMBO, ON JUNE 23, 1950, AT 2.30 P.M.

Present.—Mr. R. C. Scott, C.B.E. (Chairman), Sir Charles Jones, C.M.G., C.C.S. (Secretary to the Treasury), Mr. G. K. Newton (Chairman, Agency Section, Planters' Association of Ceylon), Messrs. H. S. Hurst, Errol Jayawickreme, Leo B. de Mel, J.P., U.M., J. C. Kelly, H. de T. Wilkinson Kay, V. G. W. Ratnayake, M.P., W. Neal de Alwis, J.P., U.M., F. A. Bond, and J. Lamb (Director and Secretary).

Letters from Messrs. D. Rhind (Director of Agriculture), R. C. L. Notley (Chairman, Planters' Association of Ceylon) and R. Singleton Salmon, C.B.E., expressing inability to be present were tabled.

1. **THE NOTICE CONVENING THE MEETING WAS READ**

The Chairman referred to the death of Dr. Norris in South Africa and said:—

> "I rise to pay our sad but honourable tribute to the memory and work of Dr. Roland V. Norris, D.Sc., who was Director of the Tea Research Institute of Ceylon from 1929 until the day of his death, April 28, 1950. He has been responsible, largely, for the development of the Institute from its early days to its present considerable quarters and status.

I feel I cannot do better than reiterate words used by Mr. J. Lamb, our Acting Director, which appeared in the "Daily News" of May 22, 1950, to the effect that the considerable and attractive quarters at St. Coombs, as well as the status and influence to which the Institute has aspired, will be a lasting memorial of Dr. Norris's perseverance and industry. I trust it will be the case that the Board of the Institute will agree that some form of Memorial at St. Coombs should record the name of Dr. Roland Victor Norris as a Director whose services to the Tea Industry of Ceylon were outstanding."

He moved that the Board's condolence be passed to Mrs. Norris and her children.

The meeting stood in silence as a mark of respect.

2. The Chairman pointed out that he considered the time had arrived to appoint a successor to the late Dr. R. V. Norris, D.Sc., as Director. He said that, at his request, Mr. Lamb had prepared a memorandum of his record as a scientist; this he read in full. He continued by saying that Mr. Lamb had been with the Institute for 16 years, and, therefore, that his experience was of very great value; additionally, that he had been in close touch with Mr. Lamb during the seven months he had been Acting Director, and had found him to be a scientist with a profound knowledge of many branches of science, and, moreover, ready and anxious to apply his knowledge in practice. He had, too, adapted himself to the administrative aspect.

It was proposed by Mr. H. S. Hurst and seconded by Mr. Neal de Alwis that Mr. Lamb, M.Sc., should be appointed Director of the Tea Research Institute of Ceylon in succession to the late Dr. R. V. Norris, D.Sc. On being put to the Board, the proposal was accepted unanimously.

On his return to the meeting Mr. Lamb was informed that he had been appointed Director on the terms outlined above.

Mr. Lamb thanked the Chairman and the Board for the confidence they had shewn by appointing him to the Directorship and said he would endeavour to justify it in full measure.

3. MEMBERSHIP OF THE BOARD AND COMMITTEES

The Chairman reported that—

(*a*) Mr. R. C. L. Notley became an exo-officio member of the Board, in place of Mr. E. G. Groves, on his assuming Chairmanship of the Planters' Association of Ceylon as from April 20, 1950. He also replaced Mr. Groves on the Finance Sub-Committee.

(*b*) Mr. F. A. Bond returned from leave, was nominated by the Agency Section of the P. A. and relieved Mr. E. N. Ewart who had been acting for him.

He thanked the outgoing members for their services to the Board and extended a welcome to the new members.

He next offered the congratulations of the Board to Sir Charles Jones and to Mr. R. Singleton Salmon, C.B.E., on the honours recently conferred on them by H. M. the King. This was received with applause.

4. SENIOR STAFF

(*a*) The Chairman reported that Mr. J. Landreth, the newly appointed Engineer, returned from Home Leave on May 29 and had assumed duties.

(*b*) The Chairman reported that Dr. F. Haworth, the new Agricultural Chemist will sail from England on July 7 and arrive in Ceylon about the end of July. He had been to the East Malling Research Station where he had obtained information on the most recent technique for investigation of minor element deficiencies. The Director had mentioned to him that he had received a very favourable report on Dr. Haworth from Dr. Tubbs.

5. LOW-COUNTRY SUB-STATION

The Chairman said that on April 17 the full Low-Country Sub-Station Committee, comprising three members from the Board and those co-opted from all Low-Country District Planters' Associations inspected Nivitigalakele Estate.

The Committee reported in favour of the proposed acquisition of Nivitigalakele for the Tea Research Institute of Ceylon Sub-Station. A valuation was called for and Mr. J. D. Farquharson valued the property and submitted a report on April 21.

A further meeting of the Board Sub-Committee together with the Finance Sub-Committee was held on May 19 prior to a joint meeting with the Rubber Research Scheme Board on May 20. Minutes of the former meeting had been circulated.

6. RESEARCH STUDENTS

The Chairman reported that Mr. D. V. W. Abeygoonewardene, B.Sc., had been given a research studentship for a period of 6 months. He was to assist Dr. Pfaeltzer of the Shell Laboratory, Amsterdam, who was working on the Blister Blight problem.

7. ST. COOMBS CADDAY

The Chairman reported that the Agreement to lease the St. Coombs Cadday building to Mr. R. P. Arnolis Silva of Dondra was signed in the morning at Messrs. Julius & Creasy's office. This was in accordance with the resolution passed by the Board on December 17, 1948.

8. ANY OTHER BUSINESS

(i) *Blister Blight.*—(*a*) The Chairman reported that Rs. 150,000 being the payment from the Tea Control Funds for the first year's work on Blister Blight was received on May 8. The Tea Controller had informed the Director that it was proposed to increase the Tea Control Cess to 10 cents per 100 lb. with a view to making a grant of Rs. 150,000 a year in the next three years. These contributions would be made available only at

the end of each control year. The next contribution was to be made available in April, 1951. As regards the mode of accounting for these payments the matter was left to the discretion of the Tea Research Institute but annual accounts would have to be forwarded to the Tea Controller for submission to the Minister of Finance.

(*b*) *Import Duty on Spraying Machinery and Equipment.*—The Chairman said that he was pleased to report that the Board's resolution on the waiving of duty on spraying machinery and fungicides to be used for Blister Blight control had met with approval of the Government.

(*c*) *Spraying Experiments.*—The Director said that the large scale spraying experiments at Kataboola had been set going and much work was being done there. He also said that Dr. Dike of the Metallo Chemical Refining Company, London, was testing out a dusting and mist-blowing machine. This machine appeared to be very promising. It was being tested on Castlereagh Estate, Dickoya. Experiments were also being carried out on Mattakelle Estate. Dr. Pfaeltzer of the Shell Company's Research and Development Organization was testing some 140 different fungicides including many of the new types.

The Director said he hoped to arrange a field day in the near future so that the industry could see some of these activities.

In reply to a question, the Director stated that due to the abnormal weather conditions which had prevailed from the beginning of the year, the outbreak of Blister Blight had been delayed. Experiments at St. Coombs had also been somewhat upset by the weather.

(ii) *Food Production.*—The Chairman reported that application had been made on June 14, 1950, to the Minister of Agriculture and Lands for St. Coombs to be exempted from the obligation of food production as has been granted to the Coconut Research Scheme.

(iii) The Chairman, before closing the meeting, said he wished to take the opportunity of expressing to Sir Charles Jones the thanks of the Board for his services by his regular attendance and very valuable advice. He wished him and Lady Jones happiness in their retirement.

Sir Charles Jones said that it was always a pleasure to him to attend meetings of the Tea Research Institute and Rubber Research Scheme Boards and thanked the Chairman and members for their good wishes.

The meeting ended with a vote of thanks to the Chair.

J. Lamb,
Secretary to the Board.

St. Coombs,
Talawakelle.

METEOROLOGICAL REPORT, JULY, 1950

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	—	—	—	—	—	—	—	—	—	—
Anuradhapura	92·2	+1·3	76·4	+0·5	57	84	6·8	0	—	— 1·32
Badulla	85·0	—1·4	64·7	+0·6	63	91	6·4	2·39	11	+ 0·22
Batticaloa	92·3	+0·1	77·5	+0·5	61	78	7·2	0·24	4	— 0·80
Colombo	84·4	—0·4	76·1	—0·9	78	88	6·9	6·99	16	+ 1·50
Diyatalawa	77·4	—0·7	63·1	+0·5	62	76	6·6	1·71	10	— 0·25
Galle	82·2	—0·6	75·4	—1·5	84	91	6·8	7·91	26	+ 1·57
Hakgala	—	—	—	—	—	—	—	—	—	—
Hambantota	88·6	+1·1	76·4	+0·1	70	84	7·0	0·17	4	— 1·84
Jaffna	85·3	—0·9	79·8	—0·1	78	82	6·4	0·36	1	— 0·19
Kandy	81·9	—0·9	70·5	—0·2	76	87	7·2	8·43	25	+ 1·11
Kurunegala	85·8	—0·6	75·1	—0·2	70	84	6·5	4·79	14	+ 0·91
Ratmalana	84·0	—	75·3	—	75	86	7·0	7·17	19	+ 1·71
Mannar	86·2	—1·3	78·8	—0·4	78	84	7·0	0	—	— 0·35
Nuwara Eliya	63·4	—2·0	54·8	0	90	94	7·8	10·91	27	— 0·11
Puttalam	86·0	0	78·1	—0·3	74	82	6·6	0	—	— 0·99
Ratnapura	86·6	0	74·4	—0·1	76	90	7·2	8·90	22	— 3·87
Talawakele	68·3	—1·9	59·5	0	87	94	6·8	13·40	30	+ 0·10
Trincomalee	93·6	+1·1	78·8	+0·7	58	78	7·0	0·64	2	— 1·09

WEATHER SUMMARY, JULY, 1950

For the fifth consecutive month rainfall in July was below normal over a large portion of the Island, but the deficits were generally small, being mostly below two inches. The larger deficits again occurred in the south-western low and mid-country, the highest being 8.03 inches at Udugama, 7.89 inches at Hapugastenne Estate, 7.82 inches at Carney Estate and 7.50 inches at Kitulgala. Excesses which were also generally small were found chiefly among the central hills and along the south-west coast, the only appreciable amounts being 8.12 inches at Pooprassie Estate, 6.39 inches at Dimbulla and 5.71 inches at Kellie Estate.

Heaviest rain occurred on the south-western slopes of the hills where several stations recorded monthly totals over 20 inches, including 31.19 inches at Norton Bridge, 27.45 inches at Luccombe Estate, 27.38 inches at Abergeldie Group, 27.19 inches at Kellie Estate, 25.47 inches at Watawala and 25.21 inches at Theydon Bois Group. In the south-western low-country the monthly aggregates ranged from 5 to 10 inches, while outside the south-west quarter rainfall was mainly below 2 inches. There was practically no rain to north of Puttalam-Trincomalee.

The weather throughout the month was of the monsoonal type but the resulting rain was generally light. The 26th was, however, a very wet day, when moderate to heavy widespread rain with squally weather was experienced in the south-west quarter. Fourteen stations on the south-western slopes of the hills recorded falls over five inches on that day, the highest being 8.67 inches at Norton Bridge and 7.0 inches at Luccombe Estate.

A hailstorm was recorded from Diyatalawa on the 8th.

Temperatures were on the whole below normal by day and about normal by night. The highest recorded temperature in the shade was 97.0° at Batticaloa on the 5th, while the lowest temperature for a low-country station was 69.7° at Kurunegala on the 27th. The lowest temperature for the whole Island was 47.8° at Nuwara Eliya on the 13th.

Day humidity was above 75 per cent. in the south-west and about 60 per cent. on the east side. Night humidity was about 85 per cent. Skies were more cloudy than usual. Wind was about average strength, the prevailing direction being south-westerly.

D. T. E. DASSANAYAKE,
Director.

SUMMARY OF OUTBREAKS OF SCHEDULED ANIMAL DISEASES WITHIN THE DOMINION OF CEYLON MONTH ENDING 30th JUNE, 1950

Province	Disease	Fresh Cases during the month	Cases up-to-date since Jan. 1, 1950	From Jan.1, 1950 to June. 30, 1950			
				Deaths	No. shot	Recoveries	Balance ill
Western Province	Foot-and-mouth	2	67	—	—	67	—
	Rabies	—	1	1	—	—	—
Colombo Municipality	Foot-and-mouth	—	430	—	—	430	—
	Anthrax	—	4	4	—	—	—
	Tuberculosis	—	2	2	—	—	—
	Piroplasmosis	—	4	4	—	—	—
	Mange	—	2	—	—	2	—
	Rabies	12	49	49	—	—	—
Quarantine Station	Anthrax (in sheep and goats)	—	41	41	—	—	—
Northern Province	Rabies	—	8	—	8	—	—
	Anthrax	121	121	121	—	—	—
	Foot-and-mouth	8	985	7	—	962	16
North-Central Province	Foot-and-mouth	306	1127	—	—	130	997
North-Western Province	Rabies	1	5	1	4	—	—
	Foot-and-mouth	—	44	6	—	38	—
Central Province	Mange (cattle)	83	556	9	—	470	77
	Foot-and-mouth	—	156	1	—	155	—
	Piroplasmosis	1	2	1	—	1	—
	Tuberculosis	1	1	—	1	—	—
Sabaragamuwa Province	Rabies	2	13	5	8	—	—
	Foot-and-mouth	—	15	—	—	15	—
Uva Province	Rabies	—	1	—	1	—	—
Eastern Province	Rabies	—	1	—	1	—	—
	Surra	—	69	69	—	—	—
	Foot-and-mouth	60	423	57	—	338	28
Southern Province	Foot-and-mouth	—	19	—	—	19	—
	Rabies	—	1	—	1	—	—

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
and Government Veterinary Surgeon.

Peradeniya, August 2, 1950.